DOCUMENT RESUME

ED 368 769 TM 021 195

AUTHOR	Kendall, John S.; Marzano, Robert J.
TITLE	The Systematic Identification and Articulation of Content Standards and Benchmarks. Update.
INSTITUTION	Mid-Continent Regional Educational Lab., Aurora, CO.
SPONS AGENCY	Office of Educational Research and Improvement (ED), Washington, DC.
PUB DATE	Jan 94
CONTRACT	RP91002005
NOTE	273p.
PUB TYPE	Reports - Evaluative/Feasibility (142) -- Information Analyses (070)
EDRS PRICE	MF01/PC11 Plus Postage.
DESCRIPTORS	Academic Achievement; Criteria; Educational Assessment; *Educational Change; Elementary Secondary Education; Geography; History; *Identification; *Job Skills; Mathematics; Models; *National Competency Tests; Reading; Sciences; *Standards; Writing (Composition)
IDENTIFIERS	*Benchmarking; *Standard Setting; Subject Content Knowledge

ABSTRACT

This update addresses major issues surrounding educational standards for all subject areas. It provides a review and analysis of standards and benchmarks in the content areas of science, mathematics, history, geography, reading, and writing. Also included is an analysis and description of the knowledge and skills considered important for the workplace. Following the introductory section on the movement for national standards, the second section provides an overview of current standards-development efforts across subject areas. Section 3 describes in greater detail the technical and conceptual differences apparent since the beginning of the standards movement and the model of standards and benchmarks adopted for this study. Section 4 presents key questions that should be addressed by schools and districts considering a standards-based strategy. Section 5 describes the overall process used to identify standards and benchmarks, and Section 6 lays out the format and citation strategy used in the standard sections. Sections 7 through 15 provide the standards and benchmarks for nine separate areas. Appendixes list declarative and procedural knowledge structures by levels of generality. (Contains 54 references.) (SLD)

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The Systematic Identification and Articulation of Content Standards and Benchmarks

Update

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January 1994

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Update

by

John S. Kendall Robert J. Marzano

January, 1994

Mid-continent Regional Educational Laboratory
Aurora, CO

This publication is based on work sponsored wholly, or in part, by the Office of Educational Research and Improvement, Department of Education, under Contract Number RP91002005. The content of this publication does not necessarily reflect the views of OERI or any other agency of the U.S. Government.

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Preface

As should be the case, the standards movement is dynamic. Since the first publication of this report in April of 1993, much more material has become available from various national study groups in the subject areas. Thus, with this update, we are able to include standards and benchmarks that cover the original National Goals subjects, as well as areas identified as important by the Secretary's Commission on Achieving Necessary Skills.

We have taken advantage of this update to elaborate on some points left undeveloped in the earlier report, to address new concerns that have arisen, and to incorporate suggestions made by careful readers. We anticipate further updates of this report, which will include revisions of these standards as well as inclusion of standards and benchmarks in additional subject areas.

A study as ambitious as this one is always the product of the hard work and creative insight of a number of individuals. The authors would like to thank the following individuals for their initial reviews of various national reports and documents: Tom Barlow, Sandy Berger, Jan Birmingham, Linda Brannan, Susan Everson, Joan Grady, Toni Haas, Judy Northup, Bob Keller, Fran Mayeski, Barbara McCombs, Joann Sebastian-Morris, Diane Paynter, Sylvia Parker, Jerome Stiller, Jo Sue Whisler and Terry Young.

C.L. Hutchins and Louis F. Cicchinelli provided invaluable suggestions to an earlier draft of this work. Alice Krueger, Debra Pickering and Janie Pollock, especially among many other colleagues, posed thoughtful questions on issues raised in this document.

Additionally, three individuals had major responsibilities for identifying various standards and benchmarks in this report:

Audrey Peralez shared major responsibility for the identification of the geography standards and benchmarks and verification of those in mathematics.

Therese Sarah shared major responsibility for the identification of standards and benchmarks in history, and assisted in the identification of the geography benchmarks.

Shelly Wasson shared major responsibility for the verification of standards and benchmarks in science, and for the identification of the geography benchmarks.

The contribution that these individuals have made to this study cannot be overstated.

JSK
RJM

1. The Call for Standards

Since the publication of A Nation at Risk in 1983 (National Commission on Excellence in Education), there has been a growing consensus on what aspects of school reform are critical to the success of our nation's students. It is now understood that in the past, teachers have relied heavily upon textbooks to determine what is important to teach in each discipline, so much so that textbook manufacturers have become the de facto standard-setting group for the content areas. Coincident with this, testing companies, by virtue of the use to which standardized tests are put in school accountability, have provided schools and districts with measures of what students should know and be able to do in order to reach certain minimum standards — in short, testing companies have provided the de facto performance standards for schools. At the same time that the identification of important knowledge, skills and performances have been relegated to textbook and test publishers, we have entered an age when information grows so rapidly that subject-matter experts are compelled to review their assumptions about the essential knowledge and skills of their disciplines. Clearly there is a need for expert subject-area guidance to determine what students should know and be able to do to prepare themselves for college and the world of work. In short, it is time to establish standards in a rigorous and systematic way.

While there is national dialogue on the development of standards, there is clearly not a consensus across groups as to what form "standards" should take, or how they should be used. The result is that the character, scope and level of detail provided in standards often varies significantly from one subject area to another. Some subject area groups have argued that the disciplines are so inherently different that a common approach to standards is not possible (Viadero, June, 1993); though, as one leading education thinker, Christopher Cross, has said, "in real life, these subjects are not as clearly defined as the experts and advocates in a field might imagine or wish" (1993). Regardless of how different the discipline areas might be from one another, they each compete for a common ground: the limited amount of time and resources in the school day. Unless standards and benchmarks are presented in a roughly equivalent and useable format, decisions regarding curriculum or assessment can quickly become problematic. For example, it is difficult for a school or district to articulate a comprehensive set of standards if one subject area describes standards in terms of a performance vignette, as is the case with the work done by the Standards Project for the Language Arts, while another subject area describes standards in terms of specific components of knowledge and skills, as is the case with the mathematics standards developed by the National Council of Teachers of Mathematics. Finally, without a common format for standards, it is not likely that educators can recognize and take advantage of the possibilities for subject-area integration afforded by the commonalities that may be found across subject areas.

The project described in this paper intends to address the major issues surrounding standards in all subject areas; this update of the project provides a review and analysis of standards and benchmarks in the content areas of science, mathematics, history, geography, reading and writing. Also included is an analysis and description of knowledge and skills considered important for the workplace; business and industry have recently identified this area of "workplace basics" as essential in the process of schooling.

The next section of this paper provides an overview of the current efforts towards standards development across subject areas. Section 3 describes in greater detail the types of technical and conceptual differences that have become apparent since the beginning of the standards movement, and describes the model of standards and benchmarks adopted for this study. Section 4 presents key questions that should be addressed by schools and districts who are considering a standards-based strategy. Section 5 describes the overall process used in this project to identify standards and benchmarks, and Section 6 lays out the format and citation strategy used in the standard sections. Sections 7 through 15 provide standards and benchmarks for nine separate areas, each section prefaced by a discussion of the process involved in generating those standards.

2. Work Completed and Work in Progress

Before describing the model of standards and benchmarks that are the basis for this project, it is useful to briefly consider the major efforts that are underway nationally to identify standards and benchmarks. These efforts will, of course, form the data base from which this project draws.

Mathematics

It is certainly no exaggeration to say that the publication of Curriculum and Evaluation Standards for School Mathematics in 1989 by the National Council of Teachers of Mathematics (NCTM), ushered in a new era relative to the role of national organizations in the practice of schooling. Through the Standards document, NCTM helped to form a new perspective on how national subject-area groups can contribute to the improvement of education when it delineated, for three levels (k-4, 5-8 & 9-12), a consensus on what students should know and be able to do, and how that might best be demonstrated in the classroom. Other organizations soon followed NCTM's lead. Since the publication of the NCTM Standards, for example, the National Assessment of Educational Progress (NAEP) developed an assessment framework for Mathematics. This document organizes the subject area into five sections, each section provided with up to a dozen statements presented as benchmark indicators; material is identified by the grade at which it should be introduced and when it should be assessed at both informal and formal levels.

Science

In science, two significant efforts are underway for the development of standards. The National Committee on Science Education Standards and Assessment (NCSESA) has produced a working paper entitled National Science Education Standards: An Enhanced Sampler. (February, 1993) This paper provides sample content standards as well as criteria for the development of standards: "...science subject matter standards will identify, from the body of scientific knowledge, a limited number of important concepts, principles, facts, laws and theories that provide a foundation for understanding and applying science" (p. 15). Four categories for the development of standards have been proposed: Science Subject Matter, Nature of Science, Applications of Science and Contexts of Science. A July '93 Progress Report provides a brief summary of the critique and consensus process. A preliminary draft of a comprehensive set of standards for science curriculum, teaching and assessment is expected in late 1993 or early 1994; the project is scheduled for completion in the Fall of 1994.

The second effort within the field of science comes from the American Association for the Advancement of Science (AAAS). Working from the foundation they helped construct in Science for All Americans, AAAS' Project 2061 produced draft material in the form of over 60 "Literacy Goals" in science as well as mathematics, technology and the social sciences. Draft benchmarks, developed for levels k-2, 3-5, 6-8 and 9-12, were circulated for review among volunteer k-12 science teachers across the country. The completed work, Benchmarks for Science Literacy (1993), has just been published.

In addition to these efforts, the National Science Teachers Association has recently revised The

Scope, Sequence, and Coordination of Secondary School Science: The Content Core (1993), a guide for curriculum designers that organizes important concepts in science along traditional subject lines.

The California Science Framework (1990) reflects indebtedness to the work done in Science for All Americans, and also shows its influence in the standards work by NCSESA. However, since it is a curriculum framework, rather than a standards document, it provides considerably more detail than found in the NCSESA standards or the Benchmarks and seems to complement them both. The framework presents the content of the physical, earth and life sciences at four levels (k-2, 3-5, 6-8, 9-12) through what it calls the major themes of science: energy, evolution, patterns of change, scale and structure, stability, and systems and interactions.

Finally, additional material on science in the schools is available from the National Assessment of Educational Progress in their Science Objectives for 1990 and the Exercise Specifications for 1994 NAEP.

Social Studies

The National Council for the Social Studies provided an initial draft set of standards at their annual meeting in Detroit in November of 1992. In Draft 2 (May 3, 1993) ten content standards summarize the field, each standard formed from such organizing themes as "Culture," "Time, Continuity and Change," and "Individual Development and Identity." Each standard has listed under it performance standards that are formed where two themes intersect. For example, under the standard for "Individual Development and Identity," where it intersects the theme "Time, Continuity and Change," at the "early grades" the performance standard listed is: "[the learner can] describe personal changes over time."

History

The History Standards Project, whose participants represent a wide range of historical associations across the United States, is currently directing a process that should result in the publication of standards in the Summer of 1994. These standards, presented with performance standards and accompanied by sample teaching activities, are developed at a considerable level of detail, and are derived from the comprehensive work, Lessons From History: Essential Understanding and Historical Perspectives Students Should Acquire (Crabtree, C., Nash, G., Gagnon, & P. Waugh, 1992).

Another useful resource, produced by the Bradley Commission on History in the Schools, is Building a History Curriculum: Guidelines for Teaching History in the Schools (1988). This document, which also appears as Chapter 2 in Historical Literacy (Gagnon & Bradley Commission, 1989), is more general in scope, and places emphasis on the essential perspectives and attitudes that students should bring to the study of history, or perhaps better, should gain as a result of its study. In addition to these two documents, the National Assessment of Educational Progress (NAEP) has developed an assessment framework for U.S. History. This document is

the result of efforts of a broad-based group of historians, educators, and citizens. As in other recent work from NAEP, this framework organizes its subject matter into themes, for example: "Change and Continuity in American Democracy," "The Gathering and Interactions of Peoples, Cultures and Ideas," and "The Changing Role of America in the World." The framework recommends some preliminary achievement levels (basic, proficient and advanced) at 4th, 8th and 12th grades. The descriptions are at a fairly general level. For example, an eighth grade student at the basic level should, among other things, "have a beginning understanding of the fundamental political ideas and institutions of American life, and their historical origins" (p. 38). In addition, there are specific, "illustrative examples," organized by theme, of content-based activities that may be appropriate for students at the 4th, 8th and 12th grade.

Civics

In other work related to the social sciences, the Center for Civic Education (CCE) is currently working to produce "National Standards for Civics and Government." This effort, made with the cooperation of the National Council for the Social Studies, has a target completion date of August, 1994. A central resource for their work will be the monumental source work, Civitas: A Framework for Civic Education (Quigley, 1991). The civics standards will address not only the skills and knowledge students should have, but the "characteristics and dispositions they should exhibit as competent and responsible citizens" (Center for Civic Education, p. 3). A recent draft (October, 1993) indicates that the level of a standard as identified by CCE will result in 73 content standards. Each content standard has associated with it a set of key concepts that students should know in order to meet the standard. The standards, in turn, are organized under two nested layers of overarching questions, so that the five outermost questions (e.g., What is government and what should it do?) each have more specific questions (e.g., What are major ideas about the purposes of government and the role of law in society?) that organize the material beneath them.

Geography

Professionals in the field of geography have also received funding to identify standards. The Geography Education Standards Writing Committee bases their work on two documents they consider fundamental. The first is the Guidelines for Geographic Education: Elementary and Secondary Schools (Joint Committee on Geographic Education, 1984), which provided an instructional framework for teaching and learning geography through structuring content around five themes (Location, Place, Human-Environmental Interaction, Movement and Regions). Since that time, NAEP's Geography Consensus Project Assessment Framework (no date) resulted in the translation of the five instructional themes into three content outcomes for assessment. The assessment framework recommends the development of questions that measure student cognitive abilities "at a basic Knowing level, a more complex Understanding level, and an Applying level that covers a broad range of thinking skills" (p. 3). This three-tiered approach, together with three content areas, "Space and Place," "Environment and Society," and "Spatial Dynamics and Connections," form a matrix within which essential assessment questions are developed. A recent draft from the Geography Standards Education Project (June 30, 1993),

explains that the themes for instruction and the outcomes for assessment were used in the development of eighteen content standards. The June draft focuses on what it terms performance standards only; a draft promised for January, 1994, should include content as well as performance standards.

In addition to these reports, another document from NAEP should have impact on the development of standards: their Item Specifications (CCSSO, 1992) for the 1994 assessment provides some detailed description as to the basic, proficient and advanced level of achievement in geography; for example, "Eighth grade basic" means that students (among other things) "...solve fundamental locational questions using latitude and longitude; interpret simple map scales; identify contents, oceans, and selected countries and cities..."(p. 54). The Item Specifications provide greater level of detail in terms of how cells in the NAEP matrix might be developed.

Language Arts

In the language arts, the Standards Project for the English Language Arts has been funded by the Office of Educational Research and Improvement (OERI) for the development of standards. The Project is a three-year collaborative effort of the Center for the Study of Reading (CSR), the International Reading Association (IRA) and the National Council of Teachers of English (NCTE). Resources for the project will likely include The English Coalition Conference: Democracy through Language (NCTE, 1989), which presents descriptions of the "person we would like to see emerge from the classroom" (p. 3) at the elementary, secondary and college levels as well as Essentials of English: A Document for Reflection and Dialogue (NCTE, 1982). Additionally, in May of 1993, the Standards Project began a survey and examination of English/Language Arts documents from state departments of education across the U.S. There are also indications that work available from NAEP, such as the Reading Framework (1990) for the 1992 Assessment, will be among the resource material consulted.

A recent draft from the Project shows five strands ("Reading/Literature," "Writing," "Language," "Real World Literacy" and "Interconnections") within each of which are listed two or three standards, described at a general level. For example, under the Writing Strand are found the standards "Talking about Writing" and "Writing for Real Audiences." Each standard is explicated by a paragraph of "Elaboration," a vignette, "Interpretation and Commentary" and "Accomplishments."

The Arts

In addition to the areas identified as part of the National Education Goals (i.e., mathematics, science, history, geography and English), several other disciplines have been funded or are developing standards independently. Funding for the Consortium of National Arts Education Associations has resulted in recent (August, 1993) draft standards for Dance, Music, Theater, and the Visual Arts, organized into k-4, 5-8 and 9-12 grade clusters. Each grade cluster contains two to six content standards under each of three headings: Creating and Performing, Perceiving and

Analyzing, and Understanding Cultural and Historic Contexts. For each content standard listed there are from one to six "Achievement Standards." For example, under the Music section, for grades k-4, the first of two content standards under "Understanding Cultural and Historical Contexts" states: "Understanding music and musical practices of the Western tradition." Of the six associated "Achievement Standards" listed, the first states: "Students describe and compare prominent characteristics of various genres of Western art music (e.g., ballets, lullabies, marches)." Across the arts there are 52 articulated content standards.

Foreign Language

A three-year project funded by the Department of Education will result in the development of standards in foreign languages, with a projected completion date of 1996. A joint effort by the American Council on the Teaching of Foreign Languages (ACTFL) and a number of foreign language associations, the work will begin from student proficiency guidelines developed in 1982 by the ACTFL. A recently circulated draft document is entitled Standards for Foreign Language Education (undated).

Physical Education

The National Association for Sport and Physical Education has recently produced a self-funded publication, Outcomes of Quality Physical Education Programs (1992). A standards document is currently under development and has a projected completion date of 1994; drafts will be available in April of 1994.

The World of Work

Progress is also being made in delineating the knowledge and skills students should have to be successful and productive in the world of work. The Secretary's Commission on Achieving Necessary Skills (SCANS) and the report the Commission produced, What Work Requires of Schools (1991), has helped to focus efforts on standards that address higher-order thinking and reasoning skills, as well as personal traits and interpersonal skills that students should acquire. This document adds a strong voice to the call from other standards groups for greater attention to the development of students' critical thinking skills, their ability to communicate, and to work in groups. The Department of Labor and the National Center for Education Statistics are currently engaged in a project to develop and administer SCANS measures by 1996.

A complementary effort was undertaken by the American Society for Training and Development (ASTD) representing "50,000 practitioners, managers, administrators, educators and researchers in the field of human development" (Carnevale, Gainer & Meltzer, 1990, p. xiii). An ASTD research team, funded through a grant underwritten by the Department of Labor, reviewed the literature and polled members to determine what skills were most desired by employers. They identified sixteen skill areas including traditional academic areas such as reading, writing and computation, as well as non-traditional areas such as interpersonal skills, self-esteem and negotiation. Their findings were published in Workplace Basics: The Essential Skills Employers Want (Carnevale, Gainer & Meltzer, 1990).

State Level Efforts

While state departments of education have long been involved in curriculum development efforts, the frameworks produced vary considerably by state in their purpose and intended audience. The authors of a few frameworks, like those for math and science from California, seem to have anticipated the current standards effort. Recently, however, some states are moving deliberately towards a standards-based view of curriculum development. In Colorado, for example, legislation for the establishment of standards-based education has resulted in the appointment of subject-area groups to develop state model standards. The members include representatives from business, education agencies and state k-16 educators, in addition to subject-area specialists.

In summary, there are a number of efforts to develop standards in a variety of subject areas. One can infer that if a school, district or state is to design a schooling system based on standards, these many and varied efforts must be reconciled to some degree.

3. Standards and Standardization

Section 1 alluded to the difficulties created by the wide variety of perspectives taken by various groups on the scope, purpose and nature of standards. In order to develop an internally consistent model of standards and benchmarks, a number of issues must be reconciled. Here we consider seven: 1) whether standards are for subject literacy or subject expertise, 2) whether standards should be content or curriculum standards, 3) whether standards should be formed as content or performance standards, 4) whether thinking and reasoning skills can be described independent of content, 5) at what level of generality standards should be stated, 6) how benchmarks could be defined, and 7) how standards organize information. The model proposed here adopts a perspective on each.

The Literacy versus Expertise Issue

Some groups, such as the National Council of Teachers of Mathematics (NCTM), have developed standards using what might be called a "literacy" model. Such standards serve to ensure that students have a basic understanding of the fundamental knowledge and skills in mathematics that an educated, literate adult should know and be able to make use of. An indication that NCTM makes such a distinction can be seen in the standards they identify separately for "the college-intending student." These standards appear to describe knowledge and skills important primarily for those in pursuit of advanced studies in math and science.

For example, in their document, Curriculum and Evaluation Standards for School Mathematics, NCTM singles out the following as applicable to students seeking to pursue mathematics at a post secondary level:

- apply the sine and cosine functions to problem situations
- investigate limiting processes by examining infinite sequences, series and areas under a curve
- analyze graphs of polynomial, rational, radical and transcendental functions

Another example is available from science. While Project 2061 does not provide "expert" standards for students bound for advanced study, the effort itself, "Benchmarks for Science Literacy" suggests that a distinction is to be made between knowledge that literate adults should possess and knowledge that is of primary use to those who plan to do advance study in the field of science. This accords with another view of science literacy, that "...*doing* science is clearly different from *using* science; scientific literacy concerns only the latter." (Hazen & Trefil, 1993) [italics, the authors']. This does not mean, of course, that students should not engage in from hands-on science; it merely suggests that there are distinctions that can be made between preparations for understanding science as an educated adult and doing basic science as an adult professional. Understanding how a motor works is different from understanding how to improve its design.

Still other standard-setting groups, for example, the National Council for History in the Schools, work from a more traditional academic model. In this model, it can sometimes appear that academic knowledge is valued for itself, and that the discipline resists the adoption of strictly utilitarian criteria for the selection of content for students. The result of such an approach may be a considerable breadth of detail found in the standards and benchmarks. For example, an early plan for U.S. History standards (March, 1993) delineated the material for every day of instruction across two years of schooling. Detail articulated at such a level could well serve the student who intends to become an historian, but it appears less certain whether it is the same information that young adults need in order to make sense of society, and their place within it.

The differences between academic and literacy models presented in the various documents do not, on close analysis, constitute an insurmountable problem. At the literacy end of the continuum, standards might be described as the minimum requirements of knowledge and skill students should know and be able to do to function well as adults of the twenty-first century. At the "expertise" end of the continuum, standards are described in terms of the knowledge and skills that, once acquired, would render students "mini-experts" in every field. In fact, as currently articulated in the documents reviewed for this effort, both positions have strong tendencies toward the middle. That is, those documents that provide what might be characterized as literacy standards commonly include material that goes beyond minimum requirements for basic literacy within a domain. Additionally, those documents that are skewed toward the expertise position frequently are structured in such a way that the "expert-level" detail provided beneath a standard does not obscure the basic point of the standard itself, which focuses on information at a literacy level.

If one had to classify the model adopted in this report, it would be most accurately described as a literacy approach to content, in that it is believed that standards and benchmarks should be considered essential for all students, whether they enter the world of work directly from high school, or go on to higher education.

Content Standards or Curriculum Standards?

A distinction that should be made in the type of standards various groups are identifying is that between content standards and curriculum standards. *Content* standards describe what a student should know and be able to do. *Curriculum* standards (sometimes referred to as program standards) are best described as descriptions of what should take place in the classroom; as such, they address instructional techniques, recommended activities, and various modes of presentation. The difference between a content and curriculum standard is illustrated by the following two statements from the National Council of Teachers of Mathematics (NCTM, 1989) framework. Within that document both statements are presented as standards:

a) recognize when an estimate is appropriate
b) describe, model, draw and classify shapes

Standard *a* describes a skill or ability a person might use solving a "day-to-day" or academic problem. For example, in day-to-day life, a person might use the skill of estimation to anticipate how much a proposed project might cost. Or in a mathematics class, a student might use his estimation skills to determine that a problem can be solved without additional, unnecessary steps. In short, estimation is a skill that is commonly used or applied to solve common day-to-day problems or accomplish goals in academic settings. Standard *b*, "describe, model, draw and classify shapes," does not share this characteristic. That is, it is difficult to imagine many situations that would demand the skill of being able to model, draw or classify shapes, whether to solve an academic or day-to-day problem. Rather, this kind of activity seems appropriate as an instructional device to help students understand shapes or to provide a way for them to demonstrate their understanding of shapes. Standards like *a* above are referred to as content standards because they describe information or skill that is essential to the practice or application of a content domain. Standards like *b* are referred to as curriculum standards because they identify the instructional or curricular activities that might be used to help students develop skill and ability within a content domain. It might be said that curriculum standards describe the methods designed to help students achieve content standards.

This project has content standards as its focus. There are two overarching reasons for this choice. First, content standards describe the goals for individual student achievement, while curriculum standards provide information that is ancillary towards reaching those goals.[1] Second, curriculum standards, which usually focus on activities, projects or techniques, if interpreted rigidly, could leave teachers with little or no room for instructional diversity. That is, if teachers or administrators interpret curriculum standards as activities that must be performed, then teaching goals can too easily be equated with the activities performed, and actual student achievement loses its primary focus. When such a prescriptive attitude is taken toward activities, they often prove inefficient and time-consuming, leaving little room for experimentation and the refinement of new approaches to teaching.

Given the content (as opposed to curricular) orientation of this project, the standards identified will quite naturally assume some of the characteristics of content area knowledge. Specifically, the standards identified within this project will generally fall into three broad categories representing the three general types of knowledge. At a very basic level, knowledge within any domain can be organized into the categories exemplified in Figure 1 (page 12).

The first column contains examples of knowledge that involve processes. These processes may or may not be performed in a linear fashion. For example, performing long division is a process: you perform one step, then another, and so on. Reading a map also involves certain steps, but these steps, unlike those in long division, do not have to be performed in any set order. You might read the name of the map first, then look at the legend, or you might just as effectively

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[1] The NCTM standards clearly show the value of curriculum standards. It is hoped that similar efforts will be undertaken in the other subject areas, once content standards are made available.

perform these steps in reverse order. Knowledge of this sort is usually called *procedural knowledge*. One might think of such knowledge as composed of the *skills and processes* important to a given content area.

Procedural	**Declarative**	**Contextual**
reading a map	democracy	know when to use a map instead of a globe.
performing long division	a numerator	model numbers using number line
setting up an experiment	an amoeba	classify organisms
shooting a free throw	rules of basketball	know when to use man-to-man vs. zone coverage
editing an essay	conventions of punctuation	use appropriate tone and style for a selected audience

Figure 1

The examples in the second column do not involve a process or a set of steps. Acquiring this type of knowledge involves understanding the component parts. For example, knowledge of the concept of "democracy" includes understanding that decisions are made by the people, each person has a single vote, votes are weighted equally, and so on. This type of knowledge is commonly called *declarative knowledge*. One might think of such knowledge as composed of the *information* important to a given content area.

The last column contains items that are not simply declarative or procedural, but specify knowledge in context. Column three contains examples of information and/or skills that have particular meaning because of the conditions that form part of their description. "To classify" is a skill; to understand the characteristics of organisms is declarative knowledge, or information; but knowledge of how to classify organisms is knowledge of a particular type: it requires understanding how particular characteristics establish relationships among organisms. Like the declarative/procedural distinction, this contextual knowledge is basic; a "piece" that cannot be further reduced without loss of important information. Also, like declarative and procedural knowledge, it reflects a kind of knowing that is primarily useful in the service of some larger goal. In the case of procedural knowledge, for example, the ability to read a map is not useful in itself, but does help when one needs to get somewhere. Similarly, declarative knowledge can

prove useful when that knowledge helps in making inferences, decisions, and the like. Understanding the concept "democracy" is not *in itself* useful (excluding knowledge for its own sake, or for so-called "academic" exercises, such as asking whether the concept has been accurately defined). It is, however, useful in the service of some larger goal, as for example, determining whether activities within a country represent the democratic process. Similarly, contextual knowledge, of itself, has limited usefulness — it does not itself describe a purposeful task, but its successful use may be essential for reaching a meaningful goal. A student may know the uses of a map and the uses of a globe, but in order to solve, for example, a distance measuring problem, the student should know the criteria for selecting between a map and a globe. This knowledge is different from simply knowing the uses of a map or of a globe (exclusively): it is knowledge about the conditions or context in which the use of one tool is more appropriate than the use of another.

Standards derived from the content position, then, will describe the declarative, procedural and contextual knowledge important within a given content area.

Content or Performance Standards?

One of the significant controversies within developing models of standards-based education is whether standards should be content- or performance-based. Some theorists describe standards in terms of knowledge and skill that should be acquired; others describe standards in terms of the tasks in which students demonstrate knowledge and skill by their performance.[2] For example, Albert Shanker, president of the American Federation of Teachers, defines a standard as "what we want youngsters to know and be able to do as a result of their education" (Shanker, 1992, p. S11). For Shanker, identifying a standard involves identifying specific information or skills that should be mastered to gain expertise in a given domain. Former Assistant Secretary of Education, Diane Ravitch, also describes standards from an information and skill perspective (Ravitch, 1992). Conversely, Grant Wiggins, a nationally known expert on performance assessment, defines standards more in performance terms. For Wiggins a standard is a real world, highly robust task that will ideally elicit or require the important knowledge and skills within various content domains (Wiggins, 1989). The emphasis on performance as the critical feature of a standard is also shared by psychologist and researcher, Richard Shavelson and his colleagues, who state that standards should be "based on students' performance of concrete, meaningful tasks" (Shavelson, Baxter & Pine,1992, p. 22).

The content versus performance issue is the least easily solved by adopting one side or the other. As described above, the content position focuses on clearly defined declarative, procedural or contextual knowledge. The performance position does not ignore the declarative, procedural or

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[2] Performance standards differ from curriculum standards in that, like content standards, they are not designed as activities for the sake of instruction, but rather are descriptions (in this case, via tasks) of what it is students should know and be able to do as a result of instruction.

contextual knowledge important within content domains, but highlights the importance of applying this knowledge in tasks. By design, a performance task describes a *specific application* of knowledge and skills.

To illustrate, consider the following performance task:

> In order to demonstrate an understanding of the effects of science, technology and society upon one another and the environment, the student will
> - determine the validity of reports on a given global, national or local environmental problem
> - propose a solution if reports are judged to be accurate
> - compose a response if the reports are judged unfounded.

This is an example of a task that might be required for graduation at the high school level. As such, for systems based on performance tasks, it is the equivalent of a content standard under which benchmarks are elaborated. One could argue that the task is too general to be useful for k-12 articulation, since it provides no information on those central concepts in the science-technology-society (STS) arena the student should know; yet it could also be argued that the task is too specific to be useful, in that the *application* that the task requires has narrowed the STS relation to environmental problems, thereby excluding other significant areas, such as questions related to health technology and space exploration. The argument is not that the task has no value, but that tasks in and of themselves cannot fully inform teachers and students about the knowledge and skills students should master by the time they graduate.

Again, by virtue of limiting the expression of knowledge and skill to that demonstrated in a particular task, performance standards have a limited scope. Another way of saying this is that what performance standards gain over content standards in depth and detail, they lose in breadth: it could take many performance standards to exhaust, if possible, the potential applications for any set of given content knowledge. Still more problematic, from the point of view of covering important knowledge and skills, performance tasks are rarely transparent as to the knowledge and skills required for their successful completion. To pose a cost-of-the-shower task to a student (Wiggins, 1993, p. 205), may be an excellent, real-world challenge, but if performance standards guide the curriculum, it is not likely clear for any teacher or student whether all students, for example, should understand the British Thermal Unit (BTU) prior to attempting the "shower" task. Conversely, if we have determined through content standards that students should understand BTU's, there are any number of tasks (including the "shower" task) that we could construct to confirm whether the student has this knowledge, and how well the student knows it.

Both content and performance standards have important functions, and both should be used. A content standard provides a clear delineation of the knowledge or skill that is deemed important within a content domain; but a content standard does not make clear how such knowledge is useful nor does it tell how well the student should understand. A performance standard describes

a task that requires the application of knowledge and skills, and also provides a way of describing how well the student understands specific knowledge and applies specific skills; but a performance task is one snapshot — it cannot describe every use of the knowledge or skill required, nor delineate all the knowledge and skills that might be brought to bear for its completion. For this reason, performance standards of themselves make a poor substitute for describing the knowledge and skills that are important in the curriculum, just as content standards make a poor substitute for describing performance.

Consequently, we believe that performance tasks (as standards) make clear how knowledge and skills are useful, but tasks in themselves fail to make clear all that is important. In other words, we are accepting the basic positions of Shanker (1993), and Ravitch (1992), namely that content standards should be used to provide descriptions of important information and skill. While in this model performance standards are not used to describe knowledge and skill, they will be used in the assessment of content standards. The design principles of the complementary systems of performance tasks will be articulated in the final report of this project.

In effect, then, content standards and performance tasks are two interdependent and necessary components of an effective system of standards. Marc Tucker, Co-director of the New Standards Project, describes the necessary integration of content standards and performance tasks:

> You can't assess kids' performance unless you give them the tasks, and you can't assess their degree of achievement unless they actually perform the tasks.
>
> But first you must be clear about what you want kids to know and be able to do, or what we call "content standards." Those content standards become the target for creating the assessment (1992, p. S3).

The Role of Thinking and Reasoning

Virtually all of the documents reviewed for this study either implicitly or explicitly acknowledged the importance of emphasizing thinking and reasoning in the articulation of standards. This is not surprising given the historical emphasis educators have placed on thinking and reasoning. Over 70 years ago, John Dewey wrote, "The sole direct path to enduring improvement in the methods of instruction and learning consists of centering upon the conditions which exact, promote and test thinking." Similarly, in 1961, the National Education Association identified the improvement of thinking and reasoning as central to American education:

> ...in the general area of the development of the ability to think, there is a field for new research of the greatest importance. It is essential that those who have responsibility for management and policy determination in education commit themselves to expansion of such research and to the application of the fruits of this research. This is the context in which the significant answers to such issues

> as educational technology, length of the school year and content of teacher education must be sought and given (Educational Policies Commission, 1961, pp. 14-15).

More recently, calls for the enhancement of thinking and reasoning in American education have come from the National Science Board Commission on Pre-college Education in Mathematics, Science and Technology (1983), the College Board (1987), the National Education Association (Futrell, 1987) and the American Federation of Teachers (1985).

Although there is agreement as to the importance of enhancing thinking and reasoning, there is not much agreement on the manner in which thinking and reasoning should be articulated in standards. There were three principal ways that thinking and reasoning skills were addressed in the documents reviewed for this report. One approach was to establish a set of standards on generic reasoning. For example, the document, Workplace Basics: The Essential Skills Employers Want (Carnevale, Gainer & Meltzer, 1991), identifies "Creative Thinking" as one of the sixteen skills that are important to the workplace. Thinking skills identified in this manner are stated as generic mental processes that cut across all content areas. A second approach can be found reflected in the National Council of Teachers of Mathematics' Curriculum and Evaluation Standards, which articulates a standard entitled "Mathematical Reasoning." Within this category, those reasoning processes presumed to be specific to mathematics, but useful within the various subdisciplines of mathematics, are identified. Finally, the third perspective is exemplified by the draft of the National Geography Standards (1993) which describes performance standards. Here no set of standards nor any one specific standard addresses thinking and reasoning. Rather, the performances are described in such a way as to embed thinking and reasoning processes. To illustrate, consider the following:

- The student can evaluate the related merits of maps, globes and other geographic tools to solve problems.

Clearly, this standard makes explicit the need to both evaluate information and solve problems, both important reasoning processes.

A cursory review of the literature in cognitive psychology would seem to favor the latter two positions. That is, strong arguments have been made against the isolation of thinking and reasoning skills (Glaser, 1984; Resnick, 1987). However, it is important to note that these arguments focus upon instruction, not upon the identification of standards. That is, the case has been well articulated that thinking and reasoning should not be taught in isolation of specific content. Quite obviously, one cannot think about nothing. Rather, thinking and reasoning processes and strategies must be employed with content, and to use any content other than that important to specific disciplines makes little sense. However, articulating standards is quite another matter. As described in this study, one of the primary purposes of standards is to provide educators with direction about the skills and abilities that should be the focus of instruction and

assessment. Yet, if important thinking approaches are only found embedded in content, there can be no way to ensure that students have explored content in as many thoughtful ways as possible. To illustrate, consider the following performance standard from the draft document of the National Geography Standards:

- The student can make and defend reasoned decisions on the location of a variety of activities within the home or community.

This performance standard describes one way in which a student might demonstrate knowledge of a content standard in geography. The content standard, however, could be addressed in a number of different ways: for example, the student could be asked to predict where types of activities might be located in a new community. In any case, the declarative knowledge identified within a content standard will be addressed one way or another. But what of the ability to make and defend a decision based on knowledge of geography? This ability is important enough to describe how a student should be able to reason using geographic information, yet whether a student employs that ability is determined by the luck of the draw — only if he or she is asked to meet this particular performance standard, or another performance standard that happens to require this skill. Clearly, a hit or miss approach will characterize any effort that does not fully articulate and address the thinking and reasoning skills that should be brought to the study of content.

The second approach found within the various national reports also proved problematic. Many of the thinking and reasoning skills and abilities identified within those standards that purported to focus on content specific skills and abilities were, in fact, quite general. For example, the NCTM standard of mathematical reasoning primarily specifies such general thinking and reasoning abilities as making conjectures, making inferences and making corrections.

Finally, we found considerable redundancy in the thinking and reasoning skills and abilities implicitly and explicitly identified in the various documents. In effect, all the discipline areas not only emphasized thinking and reasoning skills and abilities, they generally identified the same skills and abilities. Given the intent of this report to capitalize on redundancies and propelled by the problems described above, we have aggregated the various elements of thinking and reasoning into a dedicated set of standards. Our method of reporting, however, should not be misconstrued as a mandate or even a suggestion that thinking and reasoning should be taught in isolation of domain specific knowledge and skill.

Level of Generality

Even a cursory review of the standards generated by different groups reveals different perspectives on the level of generality of a standard. That is, levels of generality differ markedly from one group to another. For example, in an early draft from the National History Standards Project, the following performance standard is presented to cover the general topic of

"Revolution and the New Nation" at Grades 5-8:

> *To demonstrate understanding of the government created by the Articles of Confederation and its effectiveness, students will be able to:*
>
> - *Compare and contrast the powers apportioned to the states and to the Continental Congress under the Articles of Confederation.*
> - *Compare and contrast such major accomplishments of the Continental Congress as the Treaty of Paris, the Land Ordinance of 1785, and the Northwest Ordinance of 1787 with the inability of the Congress to deal with problems of national finance and trade.*
> - *Explain the importance of the Northwest Ordinance in the development of new states, its restrictions on slavery, its provisions for public education, and its statement of national Indian policy.*

Seven additional performance standards follow these for a total of nineteen statements at the level of specificity of the bulleted statements above.

By contrast, a draft from the National Council for the Social Studies (NCSS) provides the following:

> *Social studies programs should include experiences which provide for the study of how people in diverse societies create and refine systems of governing so that students can:*
>
> Performance standards:
> - *examine persisting issues involving the rights, role, and status of the individual in relation to the general welfare.*
> - *explain the purposes and describe alternative systems of government.*
> - *analyze ideas and mechanisms to regulate territory, manage conflict, and establish order and security.*

Six additional performance standards under this topic heading are listed in the NCSS draft. Clearly, this latter example is at a much more general level than the previous example. This is an important point, since the level of generalization adopted by a group will affect the level of detail within the standards, the kind of comprehensiveness the standards aim for and, ultimately, the number of standards the group produces.

To fully understand this issue it is important to understand the concept of levels of generality as it applies to declarative, procedural and contextual knowledge. Both declarative and procedural knowledge can be ordered in somewhat of a hierarchy in terms of levels of generality. At the top end of the hierarchy are concepts and principles with concepts being the more general of the two.

At the bottom end of the hierarchy are facts. In between are structures such as time sequences, episodes and the like. (Appendix A contains a detailed discussion of the types of structure within a declarative hierarchy.) Although facts are certainly important, concepts and principles, by virtue of the fact that they include and usually organize facts and other structures, are more appropriate for identification as declarative content standards, since they subsume other structures.

Procedural knowledge can also be ordered in a hierarchic fashion based on levels of generality, although the specific types of procedural structure are not as well defined as they are for declarative knowledge (Appendix B contains a discussion of the types of structure within procedural knowledge.) At the top of the hierarchy are highly robust and comprehensive processes that have a diversity of possible outcomes or products and involve the execution of many interrelated subprocesses. Usually these subprocesses must be learned early, and to a level of automaticity or near automaticity. Once these subprocesses are well practiced, the student spends more effort in what could be called the "executive control" of the learned subprocesses. Executive control involves regulatory activities such as deciding which subprocess is required at a particular point in time, evaluating the functions of that subprocess and planning the most appropriate activities to come next. We will call procedures that have these characteristics macroprocesses. For example, writing fulfills the defining characteristics of a macroprocess. Writing has a variety of possible products in that one can use the macroprocess to create expository discourse, narrative discourse and so on. Additionally, to perform or execute the macroprocess of writing one must execute at an automatic or at least semi-automatic level such subprocesses as correcting faulty diction, correcting mechanical errors, controlling for logic of presentation, controlling for clarity of expression, and so on. Finally, even the most effective writer must expend a great deal of mental energy in the executive control of these subprocesses.

Somewhat in the middle of the hierarchy are processes that cannot result in the variety of products possible from macroprocesses, and do not incorporate within them as wide a variety of subprocesses as do macroprocesses (although they may involve some). These procedures are commonly referred to as tactics or strategies. For example, an individual may have a tactic or strategy for solving a particular type of problem. Obviously, tactics and strategies are commonly the subcomponents of macroprocesses. For example, within the macroprocess of writing, an individual will have strategies or tactics for performing such functions as: revising a composition to make it more organized; finding and correcting diction errors and so on. Commonly, strategies and tactics are not comprised of a set of steps to be performed in a specific order. Rather, they are comprised of general rules that are commonly executed in a particular order, but do not have to be executed in a specific order. For example, most people have a strategy for reading a graph which might include rules like the following: 1) determine the elements that are depicted by reading the legend, 2) determine what is reported by one axis of the graph, 3) determine what is reported by the other axis of the graph, and 4) determine the relationship between the elements in the two axes. Although there is a general pattern in the sequence in which these steps are executed, there is no rigid set of steps. Consequently, there will be a great

deal of variation in the manner in which different learners approach the process of reading a graph.

Finally, at the bottom of the procedural hierarchy are algorithms. These procedures normally do not vary in application, have very specific outcomes and must frequently be learned to the level of automaticity to be useful. For example, many computing processes in mathematics and decoding processes within reading are algorithmic in nature. Again, algorithms are frequently the subcomponents of macroprocesses and/or strategies.

Contextual knowledge is a composite of declarative and procedural knowledge. Specifically, contextual knowledge is commonly comprised of declarative information that provides guidance regarding the use of procedural knowledge, or procedures that are important uses of declarative knowledge. To illustrate, consider the contextual knowledge in Figure 1. "When to use a map instead of a globe" is declarative knowledge that provides guidance relative to two important procedures — using a map and using a globe. "Modelling numbers using a number line" involves a procedure (modelling using a number line) that is an important use of declarative knowledge about numbers. Contextual knowledge can be applied to high level or low level declarative and procedural knowledge. That is, a learner might have contextual knowledge regarding a high level concept or a low level fact. Similarly, a learner might have contextual knowledge regarding a high level macroprocess or a lower level algorithm.

In summary, declarative, procedural and contextual knowledge can be organized in a hierarchic format based on level of generality. Consequently, from a strictly cognitive perspective, standards are perhaps best defined as the high-level declarative, procedural and contextual knowledge that are important within a domain. Ideally, one might say that standards should articulate the highest level of concepts, generalizations, macroprocesses and contextualized versions of these components. However, as described later in this section under "How Standards Organize Information," not all standards identified in this report can be described using such straightforward cognitive criteria.

The Structure of Benchmarks

Regardless of their position on standards, most groups acknowledge the need to identify expected or anticipated performance at various developmental levels. These statements of expected knowledge and skill are referred to as "benchmarks." To illustrate, consider the following content standards within mathematics:

demonstrates number sense and an understanding of number theory

At the twelfth grade level, the benchmark or expected level of performance might be described in the following way:

demonstrates a comparative understanding of the real number system and its various subsystems

At the eighth grade level, the benchmark or expected level of performance might be:

represents and uses numbers in a variety of equivalent systems including integers, fractions, decimals and percents; demonstrates an understanding of primes, factors, multiples, ratios and proportions

Theoretically, benchmarks could be identified at all grade levels. However, the trend seems to be toward developing benchmarks at a few key levels. For example, the National Assessment of Educational Progress (NAEP) identifies benchmarks at grades 4, 8 and 12. The American Association for the Advancement of Science (Project 2061) identifies benchmarks at grades 2, 5, 8 and 12.

In this model, benchmarks identify expected understanding or skill at various levels and will be articulated in terms of structures below the level of generality described by the standard. Within standards declared at the macroprocess level, subprocesses and supporting information will be found at the benchmark level. For declarative knowledge, supporting facts and other types of information are found in benchmarks beneath broader concepts and generalizations. Contextual knowledge, since it is particularized by setting, purpose, or other conditions, will also be found at the benchmark level as opposed to the more general standard level.

Also within this model, benchmarks will be provided at four levels, roughly corresponding to k-2, 3-5, 6-8, 9-12. There are two reasons for this. First, it is easier to collapse the information (i.e., to treat levels I and II as equivalent to k-4) if necessary, than to reconstruct or rediscover lost information on developmental levels, as would be the case if districts tried to tease out Levels I and II from aggregated k-4 information. Second, in our experience, primary teachers have often requested benchmarks at the k-2 level, but no one has argued that information should, for some reason, be collapsed into the k-4 range.

How Standards Organize Information

As described in a previous section, from a strict cognitive perspective, one could construct a case that a standard should identify a concept, generalization or macroprocess at a level of generality that accommodates the benchmark statements found beneath it. However, while performing our analysis, we frequently found that the range of knowledge and skills found in benchmark statements requires a more general heading than a single concept, generalization or macroprocess; thus, a standard, as articulated in this report, might better be thought of as a category of closely related ideas within a subject discipline. Just how such ideas are related to each other and to the standard under which they appear often varies between, and even within, subject areas. To understand the variety of types possible, consider a selection of standards that

will be found in this report:

Reasoning: Understands and applies basic principles of presenting an argument.
Communication: Communicates ideas and information in writing.
Science: Understands motion and the principles that explain it.
Mathematics: Uses basic and advanced procedures while performing computations.
Geography: Understands the characteristics and uses of spatial organization of the Earth's surface.
History: Understands how American external relations changed during the Revolution and in the era of the early republic.

The standard for reasoning suggests that both declarative (understands basic principles) and procedural (presenting an argument) knowledge will be found as benchmark information. Thus, it is a combination of high-level declarative and procedural knowledge. The sample standards for communication and mathematics, by contrast, describe macroprocesses. They are more procedural in nature. The samples from geography, history and science focus on declarative information.

A useful way of understanding standards is to examine the relationship between standards and their benchmarks from the perspective of classical and non-classical categories (Lakoff, 1987; Murphy & Medin, 1985). In a classical category, each item meets a necessary and sufficient condition for inclusion. For example, under the History standard, "Understands how American external relations changed during the Revolution and in the era of the early republic," we would be correct in anticipating that each benchmark found under that standard would 1) address events and relationships within a certain period of time (a time somewhat before the Revolution to the end of the early republic), and 2) address events that characterized or affected the relations between the U.S. and at least one other country. We would exclude from this "category" any item that did not meet these conditions. Thus, each benchmark meets the necessary conditions according to the description of the category that the standard provides.

Yet countless events, important or trivial, could meet these "necessary" conditions. Far fewer items would meet both necessary and sufficient conditions. The necessary conditions, as in the case of this history example, are often not difficult to deduce. The sufficient conditions, that is, those conditions that warrant that an event or relationship is "important enough," and should be known by students, are much less apparent. The criteria for those conditions are established by the various subject area groups who have undertaken the task of standard setting within their domains. Given the level of expertise of the authors of the subject area reports, one can assume that the criteria used to identify the information contained in those reports are developed from a thorough knowledge of the discipline, an understanding of pedagogy specific to the discipline, as well as realistic expectations as to the time allotted the subject area in the school year.

Readers of this report will find that some of the standards fit the criteria of classical categories.

This occurs in two general areas. As we have seen, an idiographic discipline like history, where individual, unique events are often the subject of study, can provide a standard that makes it possible to predict whether an item falls under one category or another. Another case of a standard that creates a classical category is in the highly-structured macroprocess, such as "communicates ideas and information in writing" which encompasses a contingent set of "sub-abilities," such as "composes simple stories that express cohesive ideas." In this case, subskills can be identified relatively easily as to whether, given the macroprocess, they meet the necessary conditions. Whether they also meet a sufficient condition (e.g., should the category include "writes a major thesis"?) is again, subject to less predictable criteria.

Most standards, however, describe "non-classical" categories that are less well-defined. Take, as an example, work from the Geography Education Standards Project. Geography standard number five is "Regions and earth's changing complexity." Given that as a heading, some might predict that the following benchmark statement is appropriately found beneath it:

- The student can describe how diverse cultures shape the characteristics of regions.

Yet, in fact, the benchmark above is found under the standard: "The nature and complexity of Earth's cultural mosaics" (p. 34). While the benchmark below:

- The student can analyze and explain distributions of physical and human occurrences with respect to observable patterns, distributions, associations, and densities.

is not found under the standard "Physical and human characteristics of place," but rather, "Spatial organization of the earth's surface" (p.12). In either case, whether a benchmark fits under one or another standard cannot be determined by "necessary and sufficient conditions." The categories as defined by these standards are so nearly related that the boundaries between them are fuzzy. This results in what is sometimes called a graded category structure, which occurs when adjacent categories (standards) share boundaries such that elements within them (benchmarks) can be perceived as belonging to either of two or more categories. In this case, a benchmark belongs "more and less" to two or more standards. This type of structure can give rise to duplicate or near duplicate benchmarks across a subject domain. Such a result is problematic, since the establishment of standards and benchmarks is in part motivated by an interest in the parsimonious expression of what students should know and be able to do. Some of the problems created by this type of category structure are addressed in the section on the Geography Standards.

Another common category type has a radial structure, which can be thought of as a center-periphery design. An illustration of this is found in the science standard, "Understands motion and the principles that explain it." Here, the category has "principles of motion" as its focus; benchmarks under this standard are all related to the center, but at different removes. For

example, since principles of motion explain certain types of phenomena, it is important that students observe and recognize the phenomena these principles explain. Accordingly, the benchmark for the earliest grades begins at the periphery, with simple observation:

Level I

- Knows that the varieties of motion include straight line, zigzag, vibrational, or circular.

In the next level, upper elementary, the type of information in the benchmark changes, to stress not simple observation, but fixed relationships that can be established by observation:

Level II

- Knows that when a force is applied to an object, the object either speeds up, or slows down, or goes in a different direction.

As the benchmarks begin to treat more abstract principles, they address a wider array of phenomena:

Level III

- Knows that vibrations (e.g., sound and earthquakes) move at different speeds in materials and have different wavelengths, and set up wave-like disturbances that spread away from the source

Until, at the highest level, the central principle is expressed quantitatively:

Level IV

- Knows that the rate of change in the motion of an object is directly proportional to the applied force and inversely proportional to the mass; the relationship between force and acceleration is described by F=ma

Obviously, if a standard centers on a principle or set of principles that explain a wide variety of phenomena, the category will have a wide scope, and cover what may at the surface appear to be disparate subjects; as in this case, the behavior of an object in motion, as well as the characteristics of sound waves.

Standards, as reported in this document, describe different types of categories, a few of which have been represented above. Standards provide a way of organizing information — those benchmarks that identify important declarative, procedural and contextual knowledge. This organization itself may provide information on how "pieces" of knowledge can be sequenced, logically or psychologically, for students' ease of learning. In this report, the standards we have developed reflect both the character of the draft materials available to us and the model we have developed for identifying knowledge. There are other ways that benchmarks can be grouped,

however, and except for the caution that developmentally sequenced information should not be lost, there appears no compelling reason why districts or schools should not feel free to organize benchmarks in whatever way they find most useful.

4. Implementation Issues

There are a number of ways that this document can be used. Before describing them, we must underscore the freedom that users of this document should feel in generating their own standards using ours as a reference point. This report was generated from basic assumptions and a particular view of knowledge that have hopefully been well-defined for the reader. Other assumptions and other views of knowledge would, no doubt, have produced a very different articulation and organization of standards. Consequently, a school or district should feel free to extract benchmarks from our standards and organize them into other standards more consistent with their assumptions and perspective of knowledge.

Before using this document, a school or district should make some fundamental decisions and address some basic issues. In this section, we consider five important questions that a school or district should address before it adopts a standards-based approach to schooling.

1. In what format will benchmarks be articulated?

One fundamental question that should be addressed as early as possible is the format in which benchmarks will be articulated. There are two basic formats a school or district might use: 1) as lists of declarative, procedural and contextual knowledge, and 2) as performance tasks. One approach to defining benchmarks is as leveled sets of declarative, procedural and contextual knowledge. Clearly, this is the approach we have taken in this document. Consequently, a school or district who wishes to take this approach could simply select the standards from our listing and the benchmarks within those selected standards. However, a quite different approach is to state benchmarks as performance tasks. In Section 3 of this report, we discussed the option of stating standards as performance tasks or as high level declarative, procedural and contextual knowledge versus the option of stating them as performance tasks. These same options must be considered when constructing benchmarks. Again, our approach has been to state benchmarks as declarative, procedural and contextual knowledge. If a school or district wished to state benchmarks as performance tasks, it would use the declarative, procedural and contextual benchmarks in our report to construct their more performance-oriented benchmarks. For example, consider the following Level II benchmark from one of the standards in science:

- Knows that things that give off light often give off heat
- Knows that mechanical and electrical machines give off heat
- Knows that when warmer things are put with cooler ones, the warm ones lose heat and the cool ones gain it until they are all at the same temperature

Each of these might be used to construct explicit performance tasks. For example, the last benchmark might be translated into a performance task in which students are presented with a specific situation where two objects — one warm and one cool — are placed in direct contact. They would be asked to hypothesize what changes in temperature would occur within each of the

objects and explain the rationale underlying their answer. They might also be asked to test the accuracy of their prediction in light of the observed results and to describe alternative explanations for the results. The benefit of constructing performance tasks such as this is that they commonly include more than one benchmark. For example, the proximity experiment with objects of different temperatures can also be used to determine student skill and ability in the following benchmark within the thinking and reasoning standard, "Understands basic principles of hypothesis testing and the scientific investigation":

- Generates alternative explanations to explain phenomena

In short, articulating benchmarks as performance tasks allows for the combining of benchmarks. As a way of using the elements of identified knowledge and skills, this combining can provide teachers with a creative and powerful way of approaching content. However, if performance tasks are "codified," and used as a means to define curriculum, the same problem arises as when standards are articulated as performance tasks — namely that of restricting the manner in which students can demonstrate their knowledge and skill in a given domain (see discussion entitled "Content and Performance Standards" in Section 3).

2. How many standards and benchmarks will be articulated?

In all, this report, still to be updated, already lists 1541 benchmarks embedded within 157 standards. Clearly, a school or district could not expect a student to demonstrate competence in all of these (although they may be a part of instruction). Sheer numbers would make such a system untenable. Given that there are 180 days in the school year and 13 years of schooling (assuming students go to kindergarten), there are only 2,340 school days available to students. If all benchmarks in this report were addressed, this would mean that students would have to learn and demonstrate mastery in a benchmark every 1.5 school days, or more than three benchmarks every week.

This illustrates that a school or district will surely have to select from the standards and benchmarks presented in this report if they wish to construct a system in which students are to be held accountable for each benchmark. A reasonable amount of benchmarks seems to be about 600 distributed in roughly the following way:

Level I:	k-2:	75
Level II:	3-5:	125
Level III:	4-6:	150
Level IV:	9-12:	250

Quite obviously, to implement this 600 benchmark cap, schools and districts would have to exclude quite a few of the benchmarks identified in this report.

3. Will all selected benchmarks be considered necessary to demonstrate competence in a standard?

One possible way to alleviate the problem of too many benchmarks is to consider benchmarks as exemplars rather than necessary components of a standard. Using this option, students would be held accountable for demonstrating a mastery of a sample of the benchmarks within a level for a given standard as opposed to all the benchmarks within a given level. To illustrate, consider the following benchmarks for the science standard, "Knows the forms energy takes, its transformations from one form to another, and its relationship to matter."

Level I

- Knows that the sun applies heat and light to earth
- Knows that an energy source, like a battery within a circuit, can produce light, sound and heat
- Knows that an object in a beam of light can cast a shadow, while other objects might bend or transmit the light

Level II

- Knows that things that give off light often give off heat
- Knows that mechanical and electrical machines give off heat
- Knows that when warmer things are put with cooler ones, the warm ones lose heat and the cool ones gain it until they are all at the same temperature

Level III

- Knows that energy comes in different forms, such as light, thermal, electrical, kinetic (motion), and sound, which can be changed from one form to another
- Understands that whenever the amount of energy in one place or form diminishes, the amount in other places or forms increases by the same amount
- Knows that temperature changes in a sample of matter are related to the loss or gain of thermal energy by the sample
- Knows that energy comes to the earth from the sun as visible light and electromagnetic radiation; the amount and type of radiation depend upon the absorption properties of the atmosphere
- Knows that energy changes involved in physical or chemical changes can be measured in the form of heat
- Knows that energy can be harnessed to do work, which is represented by the quantity of force applied to an object times the distance the object moves in the direction of force

Level IV

- Knows that heat energy in a material consists of the disordered motions of its colliding atoms or molecules
- Knows that any interactions of atoms or molecules involve either a net decrease in potential energy or a net increase in disorder (entropy), or both

- Knows that transformations of energy usually produce some energy in the form of heat, which by radiation or conduction spreads into cooler places, so that less can be done with the total energy
- Knows that characteristic energy levels associated with different configurations of atoms and molecules means that light emitted or absorbed during energy transformations can be used to provide evidence regarding the structure and composition of matter
- Knows that some changes of atomic or molecular configuration require an input of energy, whereas others release energy
- Knows that the difference in the strength of forces involved in nuclear particles and those associated with molecules are reflected in the differences in energy released in nuclear and chemical reactions
- Knows that energy transformations occur whenever the nuclei of very heavy atoms, such as uranium or plutonium, split into middle-weight ones, or when very light nuclei, such as those of hydrogen and helium, combine into heavier ones

A school or district who takes the "exemplar" approach to benchmarks would require students to demonstrate competence in a selected number of benchmarks per level. For example, a school or district might require students to demonstrate competence in two out of the three benchmarks for Level I; two out of three for Level II; four out of six for Level III; and five out of seven for Level IV. This approach would allow a school or district to "exceed" the recommended limit of 600 benchmarks discussed in the preceding section. It would also allow for more flexibility within the classroom in that individual teachers would have the option to use those benchmark components which they judged as most applicable for their students. However, this approach also results in less continuity of coverage within a content domain since different teachers will no doubt select different benchmark exemplars to illustrate student competence within the levels for a given standard. It is also important to note that this approach may defeat the designed purposes of some well-articulated standards, such as those developed by Project 2061; that is, upper level benchmarks depend on the fact that students are familiar with a logically prior concept, addressed at an earlier level. If teachers select without regard to articulation, some of the value of this approach may be lost.

4. Will student performance be reported using course grade or standards?

Currently, most schools and districts report student progress using appropriate grades for broad academic areas organized within courses. However, current research and theory indicate that courses of the same title do not necessarily cover the same content (Yoon, Burstein & Gold, undated). In other words, two courses of the same name do not necessarily cover the same declarative, procedural and contextual knowledge. If a school or district wished to use traditional grades, but implement a standards-oriented approach, they would ensure that the benchmarks that have been identified would be distributed systematically throughout the various courses within content areas. That is, specific benchmarks would be assigned to courses based upon the elements they cover. Any two courses with the same title would not only cover the same

benchmarks but would place the same relative importance on the benchmarks they cover. For example, assume that two courses of the same title were designed to cover the same seven benchmarks. The school or district could also determine which percentage of the grade each benchmark would command. In such a case, it might be determined that the first two benchmarks each accounted for 25% of the grade and the remaining five benchmarks each accounted for 10% of the grade. Clearly, this would provide more precision for course descriptions, and show an equivalence between "identical" courses that is not often found today.

In summary, traditional grading practices and standards-based assessment are not incompatible. A school or district must simply distribute and weight the standards that have been identified across the various courses in a systematic, well-reasoned fashion.

The second reporting option a school or district might take is to report student progress by benchmarks. That is, rather than assign a single grade to a course, a teacher would report progress in some way for each benchmark covered in the course. In effect, for assessment purposes only, each benchmark component would be considered independent of the others covered within the course. When this approach is taken, schools and districts commonly employ rubrics as opposed to grades.

A rubric is a description of the levels of understanding or skill for a given benchmark. For example, below is a rubric for the Level II mathematics benchmark "Understands the role and function of place value":

4. Demonstrates a thorough understanding of the role and function of place value and provides insights that are not obvious when using the concept of place value.
3. Demonstrates a complete and accurate understanding of the role and function of place value as it relates to estimating or calculating addition, subtraction, multiplication and division.
2. Displays an incomplete understanding of the role and function of place value as it relates to estimating or calculating addition, subtraction, multiplication or division.
1. Has severe misconceptions about the role and function of place value as evidenced by severe place value errors in addition, subtraction, multiplication or division.

Commonly, one of the described levels within a rubric is designated as the targeted level of skill or knowledge. For example, level 3 in the reporting rubric above might be selected as the target standard for the Level II mathematics benchmark "Understands the role and function of place value." In effect, if a task were constructed to help assess a student's ability in this area, a description of achievements on the task would parallel this reporting rubric, but be couched in terms of the task performance. Successful achievement on the task, that is, meeting the performance standard, would provide some evidence that the student had reached level 3 on the

reporting rubric.

Reporting out by benchmarks would, of course, require a record-keeping system that is far different from that currently used in most schools and districts. Each student's score on individual benchmarks would be recorded. Assuming the use of a 4-point rubric, individual students would receive a score of 1 through 4 on each benchmark assessed within each standard. These scores could then be averaged to obtain an overall standard score at a given benchmark level.

5. Will all students be required to meet all standards?

A major decision facing a school or district who wishes to emphasize content area standards is whether students will be required to meet a targeted level of knowledge and skills. This approach is reminiscent of the mastery learning approach of the 1970's and early 1980's (see Levine & Associates, 1985), and the more recent outcomes-based approach or OBE approach (Spady, 1988). In the context of the reporting rubric described previously, a mastery or outcomes-based approach would mean that students would be required to receive a score of 3 on each benchmark. If a student did not meet the standard for a benchmark (i.e., did not obtain a score of 3 on the rubric), he or she would be provided with additional instructional opportunities until he or she could meet the required proficiency. Of course, such a system makes extreme demands on resources. In a traditional system, no extra resources need be used if a student does poorly in a course. In a mastery or OBE system, each student who does not meet a standard must be provided with whatever instructional and curriculum resources are necessary to ensure that the student meets the requirements. A variation in the theme of a comprehensive mastery or outcomes-based approach is to require that students meet the performance standards on *some*, but not all, benchmarks. Those benchmarks which are applied to all students would be considered a set of core requirements.

In summary, there are many important decisions a school or district must make regarding the implementation of a standards-oriented approach to schooling. In this section, we have discussed five of the decisions that deal with the nature and function of standards and benchmarks and the extent to which students will be held accountable for them.

5. The Process Used in This Report

Although some variations exist in the manner in which standards from different domains were addressed, a general process was followed to identify the standards in this report.

Identify National Reports
In February of 1990, the President and state governors established a set of national educational goals. One of those was that by the year 2000, American students would demonstrate mastery over challenging subject matter in the domains of science, history, English, mathematics and geography. Given this national mandate for improved student performance in these core academic areas, the most significant documents in the following areas were identified: mathematics, science, history, geography, reading, and writing. It is important to note that a number of documents used were in draft form. All relevant documents are discussed in the appropriate subject sections.

In addition to these "core" content areas, documents were also reviewed from the domain of the workplace. This was done to meet the growing demand for a smoother transition from school to the workplace.

Select Reference Documents
Since there was more than one document within many of the domains considered, a reference report was selected for each domain. Reference documents were selected based on their completeness, perceived acceptance by the subject discipline community, and compatibility with the perspective of standards and benchmarks taken in this report.

Identify Standards and Benchmarks
Once a reference document was selected, standards and their benchmarks were identified. This was done from both "top down" and "bottom up" perspectives. A top down perspective was taken when a reference document contained explicit standards that were at a level of generality consistent with position on standards taken in this study. In such cases, the standard found in the reference document was accepted with minor modifications, or if rewritten, kept close to the original meaning. Benchmarks were then identified for each standard. Depending upon the character of the document, this process could entail the straightforward identification of explicitly stated benchmarks, or could require an analysis to find implicit information. In some cases, however, a reference document articulated standards at a different level of generality (too general or too specific), or in a different format (performance or curriculum standards as opposed to content standards). In such situations, implicit and explicit benchmark components (declarative, procedural and contextual elements) were identified first. These were then organized into standards. In effect, such standards were designed from the bottom up.

Integrate Information From the Other Documents
When the analysis of the reference document was complete, information from the other documents was then integrated into the standards and benchmarks identified from the reference

document. On some occasions, the analysis of secondary documents within a domain illustrated a need to create new standards that were not explicit or implicit in the reference document.

Organize Standards into Categories

In all, this report describes 157 different standards and their related benchmarks. These standards have been organized into 9 major categories.

The standards and benchmarks were organized into larger categories. In a number of cases, the organization was straightforward; for example, standards generated from and referenced to science documents were placed under the category of science. Such an approach was followed for the areas of mathematics, geography and history. For other categories, the "bottom up" approach that characterized the formation of standards from benchmarks also was used to organize similar standards into larger areas. The nine categories are:

1. Science: 34 standards with 507 benchmarks. Science includes standards on earth and space science, the life sciences and physical science.

2. Mathematics: 8 standards defined in 125 benchmarks.

3. History: history standards comprise U.S. History (37 standards and 143 benchmarks) and World History (31 standards and 138 benchmarks). In addition, one standard, with 12 benchmarks, addresses historical perspective and judgment.

4. Geography: geography standards address a broad range of subject matter; there are 251 benchmarks in 18 standards.

5. Communication and Information Processing: The information processing standards deal with the comprehension, understanding and representation of information gained from print and other media. It also deals with the communication of information in a variety of media, but with an emphasis on writing. This category includes many of the reading and writing skills and abilities commonly associated with the English language arts. 125 benchmarks are found in 5 standards.

6. Thinking and Reasoning: Thinking and reasoning standards deal with the mental processes involved in evaluating information, solving problems, constructing arguments and the like. 68 benchmarks are found across 6 standards.

7. Working with Others: These standards deal with the skills and abilities considered important to collaboration and cooperation in the workplace and in a general social context. 5 standards contain 48 benchmarks.

8. Self-regulation: The self-regulatory standards encompass those skills and abilities

commonly associated with establishing and monitoring goals and maintaining a healthy sense of self. 56 benchmarks are found in 5 standards.

9. Life Work: Life work standards deal with the skills and abilities necessary to secure and maintain employment. 7 standards contain 68 benchmarks.

6. How the Subject-Area Sections are Structured

As described previously, standards may be procedural or declarative statements or may be statements that describe broader categories; they may be taken directly from draft documents, or may have been constructed inductively or extrapolated from an analysis of the documents in the subject area. The benchmarks in this document, however, are all statements of declarative, procedural and contextual knowledge taken from a wide range of national reports. These benchmarks are organized under the standards at four levels.

Level I	=	k-2, or primary
Level II	=	3-5, or upper elementary
Level III	=	6-8, or middle school
Level IV	=	9-12, or high school

The standards are organized and reported in the 9 categories described in the previous section. Each standard within a category is numbered consecutively (the numbering sequence has no significance, and was done for ease of reference). The benchmarks are listed immediately under each standard, and presented by level (I-IV). A set of codes, with a key provided at the bottom of the page, provides the following information for each benchmark: the cognitive character of the benchmark (whether it is declarative, procedural or contextual); a citation wherever the benchmark information was found in reference and supporting documents; the nature of each citation, that is, whether the information was found explicitly stated, or could be implied from other statements; and finally, in the case of duplicates, where very similar benchmarks can be found within the same category.
To illustrate:

(NI,74)

5. Understands the concept of regions
Level III

BD (NI,56-57;SE,18;DI,10.3.1)

- Understands criteria that give a region identity (e.g., central focus of a region, physical and cultural characteristics)

"Understands the concept of regions" appears as the fifth standard in the Geography section, and the benchmark shown is at level III. Just above the benchmark, and flush right, is the abbreviation "BD," followed by the "citation log": (NI,56-57;SE,18;DI,10.3.1). A key like the following is provided for each subject area:

Codes (right side of page): BD=Benchmark, Declarative; BP= Procedural; BC= Contextual

1st letter of each code in parentheses	*2nd letter of code*	*Number*
G = Guidelines for Geographic Education	E = Explicitly stated in document	Page number of cited document
N = NAEP: Geog. Item Specific.	I = Implied in document	*or, for duplicates:*
S = Geog. Education Standards Project		Standard number & level of duplicate
T = K-6 Geography: Themes, Key Ideas		
D = Duplicated in another standard		

The key identifies "BD" as a benchmark that describes declarative knowledge. Within the parentheses that follow "BD," there are two documents cited, separated by semicolons. The first, NI,56-57, indicates that the information described in the benchmark can be found implied in the NAEP Item specifications document on pages 56 and 57; the second, SE,18, indicates the information is also found explicitly stated in the Geography Standards document on page 18. (Full citations for all reports are found in the bibliography). The last piece of information "DI,10.3.1" indicates that another benchmark contains very closely related information. In this case, that particular benchmark is under the standard number 10, at level 3, and is the first bulleted item.

Additionally, when the idea expressed at the standard level has been identified in supporting documents, that information is provided in parentheses, flush right, just above the standard statement. In the example above, the idea that students should have a general understanding of the concept of regions has also been found (NI,74) in the NAEP document, on page 74.

7. Science

The following process was used to identify standards within the field of science.

Identification of National Reports
Three reports were identified as central documents for representing current thinking on standards within science: Project 2061's Benchmarks for Science Literacy; (1993); the work available in drafts from the National Committee on Science Education Standards and Assessment (NCSESA;1993, February & July); and the National Science Teachers Association's Scope, Sequence, and Coordination of Secondary School Science: The Content Core (1993). Additionally, supporting citations were culled from the Science Framework for California Public Schools (1991), and two reports from NAEP (Science Objectives for 1990 and Exercise Specifications for 1994 NAEP).

Selection of the Reference Document
Project 2061's Literacy document was selected as the principal document for several reasons. First, the material for Literacy, although in draft form, was nearly complete at the beginning of this project, while the National Science Standards effort was just beginning to form; second, the authoring committee and its sponsoring agency (AAAS) enjoy widespread professional respect in the field; and third, the effort was based on a considerable body of work, Science for All Americans (1989), whose influence is clear both in the National Standards draft material as well as in California's Science Framework.

Identification of Standards and Benchmarks
Examination of the Literacy document showed it to be amenable to our model for standards development in several important respects. The statements labelled "Literacy Goals" were pitched at about the appropriate level of generality for standards within our model; that is, these statements generally allowed for benchmark material articulated across k-12; also, the draft provided benchmarks for Literacy Goals at grades k-2, 3-5, 6-8, and 9-12, a range which accords with our preference for four benchmark levels under each standard.

There were some aspects in which 2061's Literacy document was not compatible with our model. At the standard level, there were a number of subject areas covered under Literacy Goals that will be, or already have been, anchored by other reference documents in our work. For example, of the 67 standards level statements listed in the Literacy draft, 8 dealt specifically with mathematics, an area for which we use NCTM's Curriculum and Evaluation Standards as a reference document. Similarly, there were additional goals in Social Sciences (7) and Technology (10) which are topics that we will address separately, with necessarily different supporting and/or reference documents. In addition, 8 goals could be described as reasoning, communication or work-related goals and, according to our model plan, are treated in separate sections of the current report.

At the benchmark level, material from the 2061 Literacy document was added to or revised in

four cases: 1) when minor modification of a benchmark statement allowed for additional citation support; 2) when the original statement carried more than one basic idea, and was divided into components; 3) when stylistic changes helped the sense of the statement; and 4) when benchmark statements not in the 2061 draft were added based on information consistently found in the other major documents. In addition, each benchmark was prefixed with the phrase "knows that" or "knows how" (in the sense, "knows how" something works or functions, not "knows how to," which could introduce a statement on procedural knowledge). It is interesting to note that there were no statements of procedural knowledge in the science document; all benchmarks introduce declarative knowledge.

Additionally, there were some instances of benchmark duplication across standards. In each case, it was clear that the benchmarks served the purpose of preparing students for more complex, related ideas at later benchmark levels. For this reason, the duplicates were not deleted, but cross-referenced in the citation log. (For more detail, see Section 6, "How the subject-area documents are structured.")

Integration of Information From Other Documents

Material from the Literacy draft, selected and revised as described above, formed the main document for the science standards and benchmarks (henceforward termed the reference document). Next, supporting documents were examined to integrate information into the reference document. Available draft material from the National Committee on Science Education Standards and Assessment (NCSESA) was studied for all statements regarding subject-area content. Many of the benchmarks in the NCSESA document were found to be explicitly stated or clearly implied within benchmarks of the reference document; where this was the case, the relevant page number for the NCSESA draft was cited. In a number of instances, a benchmark level statement would be altered in some degree to accommodate an aspect of information covered in NCSESA but not present in the reference document. Also, if a statement was found in the NCSESA document for which an explicit or implied equivalent could not be found, the information was added directly to the reference document, under an appropriate standard, in the form of a benchmark statement. This was done whether or not the information was discovered in supporting documents as well, primarily so that we could assure that all benchmarks from the National Standards group were present in the reference document.

The other primary document used to integrate information was NSTA's Content Core. This work, like the California Science Framework, was referenced to provide science teachers with ready access to sources via page number citations keyed to the benchmarks. In addition, the Content Core provided a means for evaluating whether additional benchmarks should be added to the reference document. If information found at the appropriate level in the Content Core could not be found in the reference document (which included at that time both 2061's Literacy information as well as NCSESA information), then it was identified for possible inclusion as an additional benchmark. A compiled list of this information was then compared against information in the California Science Framework and the two documents from NAEP. If the

information was found to be present in at least three documents (the Content Core and two of the three supporting documents) it was integrated into the reference document as a benchmark. Evidence for this process can be found by an examination of the "citation log" found associated with each benchmark: if the benchmark does not show a reference to the 2061's Literacy, or the National Standards work, then it was added to the reference document using the process just described.

(2E,2)

1. Understands the convictions scientists share about the nature of the world and what can be learned about it

Level I

BD (2E,4;OE,26)

- Understands that science experiments normally have reproducible results: science experiments generally work the same way in different places

Level II

BD (2E,4;OE,26)

- Understands that the same scientific investigation often gives slightly different results when it is carried out by different persons, or at different times or places; however, if the results of repeated experiments are very different, something must be wrong with the design of the investigation

BD (2E,4;OE,26)

- Understands that scientists often repeat an experiment many times before accepting a consistent result as true

Level III

BD (2E,5;OE,23,24)

- Understands that scientific knowledge is subject to modification

Level IV

BD (2E,5;NI,87;DI,25.4)

- Understands that Newton's assumption of the universal applicability of the principles of motion and gravity reflects a belief in science that the universe is a single system in which basic rules are the same everywhere

BD (2E,6;OE,26)

- Understands change and continuity are regular features of science: scientific revolutions, such as those associated with Copernicus, Darwin, Lavoisier and Einstein introduce

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1st letter of each code in parentheses
2 = Project 2061: Benchmarks for Science Literacy
C = California Science Framework
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radical change, but more often changes are small modifications of prior knowledge

BD (2E,6;OI,21)

- Understands how science improves its predictions and explanations of the world through the continuous testing, revising and occasional discarding of theories; this leads to better understanding of the world, but not to absolute truth

BD (2E,6)

- Understands that science can inform (but not resolve) moral decisions and other matters that cannot be proved or disproved, by identifying the likely consequences of particular actions

(2E,6)

2. Understands that scientific inquiry works in particular ways

Level I

BD (2E,7;OE,26)

- Understands that learning can come from careful observations and simple experiments

BD (2E,7;OI,20,21;DI,12.1)

- Understands that tools like thermometers, magnifiers, rulers, or balances add to information from our senses

BD (2E,7;OI,20)

- Understands the importance of careful description in science and how it allows comparison

BD (2E,7)

- Understands that individuals can interpret the same thing in different ways

Level II

BD (2E,8;OI,21)

- Understands the many forms scientific investigation can take: naturalistic observation of things or events, data collection, and controlled experiments; and the kinds of questions it attempts to answer: physical, biological and social

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BD (2E,8;OE,21,23)

- Understands that scientists can have different explanations for the same set of observations, but all scientists expect explanations to be logical arguments backed up by evidence

Level III

BD (2E,9;OE,21,24)

- Understands that there is no fixed procedure called "the scientific method," but that investigations involve carefully collected, relevant evidence, logical reasoning, and some imagination in developing hypotheses and explanations

BD (2E,9;OI,21)

- Understands that if more than one variable is changed at the same time in an experiment, a change in the outcome may not be clearly attributable to any one of the variables

BD (2E,9;OI,21)

- Understands that preventing the influence of outside factors is often difficult, and that research designs should be examined for their presence

BD (2E,9;OI,23-24)

- Understands that expectations and strong beliefs can affect objectivity and that scientists regularly take steps to safeguard objectivity through the design of their investigations, the examination of data, and the use of independent review

Level IV

BD (2E,10;OE,21)

- Understands that experiments are done for different reasons, including to explore new phenomena, check previous results, to test a theory, and to compare different theories

BD (2E,10;OI,21)

- Understands that when controlling conditions in order to obtain evidence is impractical or unethical, scientists use repeated observations of natural occurrences to be able to discern patterns

BD (2E,10;OI,23-24)

- Understands that science has different traditions about what is studied and how, but there

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are shared beliefs in the value of evidence, logic and good arguments, and that progress in science comes from intelligence, hard work, imagination and even chance

BD (2E,10)

- Understands that new ideas often encounter vigorous criticism in science, but are ultimately judged on how they fit with other theories and their capacity to explain and predict

BD (2E,10)

- Understands that groups of scientists tend to see things alike, and so are expected to guard against threats to objectivity in the design of their investigation and data analysis

(2E,10)

3. Understands the main individual, social, ethical and institutional aspects of science

Level I

BD (2E,12)

- Understands that in science it is helpful to work with a team and share findings with others

BD (2E,12)

- Understands that learning can come from close observation of plants and animals, but they should not be mistreated

Level II

BC (2E,12)

- Understands that written communication is an essential part of doing science

BD (2E,12)

- Understands that doing science involves many different kinds of work and many different kinds of people

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Level III

BD (2E,13)

- Understands that scientists and science technicians are employed in education, government, business, industry and work in offices, classrooms, farms, factories, and in field settings

BD (2E,13)

- Understands that the ethics of science require that potential subjects be fully informed of the risks and benefits associated with the research and their right to refuse to participate

BD (2E,13)

- Understands that because animals cannot make informed choices, special care must be taken in using them in science research

BD (2E,13)

- Understands the value of computers for speeding up and extending the ability to store, compile, analyze and share data; to prepare research reports, and share ideas with others all over the world

Level IV

BD (2E,14)

- Understands that science disciplines differ from one another in what they study, their techniques and goals, but share a common purpose and philosophy

BD (2E,14)

- Understands that disciplines provide a conceptual structure for organizing knowledge, but they do not have fixed boundaries: many problems cross disciplines, and new disciplines can form where existing ones meet

BD (2E,14)

- Understands that research involving human subjects may be conducted only with the informed consent of the subjects

BD (2E,14)

- Understands that most scientists consider a decision to participate in research that has potential risks for society to be a matter of personal rather than professional ethics

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BD (2E,14)

- Understands that scientists in their area of expertise can bring information, insights and analytical skills, but outside their areas can be just as biased as other people and should enjoy no special credibility

BD (2E,15)

- Understands that the traditions of accurate record keeping, openness, replication and peer review keeps the majority of scientists within the bounds of ethical behavior; violations of this behavior are eventually exposed and strongly condemned

(2E,42;CE,79;NI,62;TE,83)

4. Understands essential ideas about the composition and structure of the universe and the motions of the objects in it

Level I

BD (2E,43;CI,84)

- Knows that the stars are innumerable, unevenly dispersed and of unequal brightness

BD (2E,43;CE,79;NI,62)

- Recognizes that while the sun can be seen only in daytime, the moon is out sometimes at night and sometimes during the day

BD (2E,43;CE,79;DI,24.1)

- Recognizes that the sun, moon and stars appear to move across the sky every day (or night)

BD (2E,43,47;CE,79-80)

- Knows that the face of the moon changes in a regular way, returning to the same shape after about a month

Level II

BD (2E,44;CI,84;NE,62)

- Understands that while telescopes magnify distant objects in the sky (like the moon and planets) and dramatically increase the number of stars we can see, some objects are so distant, small or dim that they do not appear in a telescope

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BD (2E,44;TE,97)

- Understands that astronomical objects in interstellar space are unimaginably distant from the earth and each other: stars are like our sun, but so distant they look like points of light, and galaxies, though very large, are so distant they look like a single star

BD (2E,44;NI,75)

- Knows that the sun is a medium-size star, located at the edge of a disk-shaped galaxy, part of which can be seen on a clear night as a glowing band of light

BD (2E,44;CI,81;NE,75)

- Knows that the universe contains innumerable galaxies, each containing innumerable stars

BD (2E,44;NI,62)

- Understands that the earth is one of several planets that circle the sun, and the moon circles around the earth

Level III

BD (2E,45;CI,86;NI,62)

- Knows that light travels from the sun to earth in a few minutes, from the next nearest star in four years, and from very distant stars, several billion years; the distance light travels in a few years would take the fastest rocket thousands of years to travel

BD (2E,45;CE,82;TE,97)

- Understands that stars differ from each other in size, temperature and age, but appear to be made up of the same elements and to behave according to the same principles; however, unlike our sun, most stars are in systems of two or more stars orbiting around a common point

BD (2E,45;CI,81;NE,73-74;TE,90-91)

- Knows that nine planets of very different size, composition, and surface features move around the sun in nearly circular orbits, and some planets have a variety of moons and rings of particles orbiting around them: the earth is orbited by one moon, many artificial satellites, and debris

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BD (2E,45;CE,81;TE,90)

- Knows that many pieces of rock and ice orbit our sun: some meet the earth in its orbit, glow and disintegrate from friction as they plunge through our atmosphere; other objects have long, off-center orbits that bring them close to the sun, whose radiation boils off material and pushes it into a long, illuminated tail

Level IV

BD (2E,45;CE,85;NE,87;TE,98)

- Knows that about ten billion years ago, the entire contents of the universe expanded explosively into existence from a single, hot, dense chaotic mass

BD (2E,45;CE,85;NE,86-87;TE,96)

- Knows that at the beginning of the universe, stars that formed out of clouds of the lightest elements became hot as the material condensed and began releasing energy from the nuclear fusion of light elements into heavier ones in their extremely hot, dense cores; some stars eventually exploded, producing clouds of material from which other stars and planets would condense: a process of star formation and destruction that continues

BD (2E,46;CE,89;NE,74)

- Knows that the scientific account of the universe comes from studying evidence about its contents and imagining, with the help of mathematical models, how they got to be the way they are

BD (2E,46;CE,88-89;NI,88;TI,96)

- Knows that current, increasingly more accurate technological tools include visual, radio and x-ray telescopes that provide information across the entire spectrum of electromagnetic waves, computers that manage large and complex data, space probes that provide data from remote parts of the solar system, and accelerators which can simulate conditions in the stars

(2E,46;NE,57,TE,79)

5. Knows basic concepts about the earth

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Level I

BD (2E,47;NE,61)

- Knows that weather changes some from day to day, but things like temperature and rain (or snow) tend to be high, low, or medium in the same months every year

BD (2E,48;NI,59)

- Knows that water can be a liquid, like rain, or solid ice, and can be made to go back and forth from one form to the other, but the amount of water stays the same

BD (2E,48)

- Knows that water in a closed container stays the same, but water left in an open container disappears (evaporates)

Level II

BD (2E,48)

- Knows that like all planets and stars, the earth is approximately spherical in shape

BD (2E,48;NE,62-63)

- Knows that the rotation of the earth on its axis every 24 hours produces the night and day cycle

BD (2E,49;NE,59)

- Knows that when liquid water disappears, it turns into gas (vapor) in the air and can re-appear as a liquid when cooled

BD (2E,49)

- Knows that air is a substance that surrounds us, takes up space, and whose movement we feel as wind

BD (2E,49;CE,99;NE,60)

- Knows that clouds, like fog and steam from a kettle, are made of tiny droplets of water

BD (CE,93;NE,57-58;TE,79)

- Knows common rocks and minerals, what they are made of, and how they form

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BD (CE,101;NE,59;TE,79)

- Knows the major differences between fresh and ocean waters

Level III

BD (2E,49;NE,64;TI,95)

- Knows that we live on a fairly small planet, the third from the sun in the only system of planets definitely known to exist (although other, similar systems might be discovered in the universe)

BD (2E,49;CE,79;TI,92)

- Knows that unlike the much larger outer planets, which are mostly gas, the earth is mostly rock

BD (2E,49;NE,59,71;TI,79-80)

- Knows that three-fourths of the earth's surface is covered by a thin layer of water, and the entire planet is surrounded by a blanket of air

BD (2E,49;CE,86;NE,74;TE,95)

- Knows that the earth is the only body in our solar system that appears able to support life

BD (2E,49;NI,76;DE,9.2)

- Knows that everything on or near the earth is pulled toward the earth's center of gravity

BD (CE,86;NE,65;TE,92)

- Knows the composition of the interior of the Earth (core, mantle, crust)

BD (CE,108;NE,70;TE,80)

- Knows the composition and structure of the Earth's atmosphere

BD (2E,49;NE,62-63;TE,89)

- Knows that because of the tilt of the earth's axis, sunlight (and hence heat) falls more intensely on one part or another of the earth during its one-year revolution around the sun; the change in the amount of heat produces the seasons

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BD (2E,49;NE,76;TE,84)

- Knows that the combination of the earth's yearly orbit around the sun and the moon's orbit around the earth once in about 28 days changes the way sunlight falls onto the moon, resulting in the phases of the moon

BD (2E,50;NE,68;TE,97)

- Knows that the earth's climate sometimes changes radically in response to the effects of geological shifts such as the advance or retreat of glaciers over centuries or a series of huge volcanic eruptions in a short time

BD (2E,50;NE,69,85;TI,89)

- Knows that even relatively small changes of atmospheric content or ocean temperature can have widespread effects on climate if the change lasts long enough

BD (2E,50;CE,99;NE,71;TE,82)

- Knows that the cycling of water in and out of the atmosphere plays an important role in determining climatic patterns: water evaporates from the surface of the earth, rises and cools, condenses into rain or snow, and falls to the surface, where it forms rivers and lakes and collects in porous layers of rock

BD (2E,50;NE,70;TI,82)

- Knows that rivers and lakes and even water that moves below the earth's surface can be depleted or polluted, becoming unavailable or unsuitable for life

BD (2E,50;NI,65,67;TI,94)

- Knows that some minerals are scarce and some are abundant, but the ability to recover minerals is just as important as their abundance; as minerals are depleted, obtaining them becomes more costly, leading to substitutes or more recycling, which adds costs

BD (2E,50;NE,67;TI,86)

- Knows that the benefit of earth's resources--like our oceans, atmosphere, topsoil and trees--can be reduced by misusing them or by deliberately or inadvertently destroying them

BD (2E,50;CI,99;NI,80,82;TI,95)

- Knows that the atmosphere and the oceans have limited ability to absorb wastes and recycle materials naturally, and cleaning up polluted air, water, or soil or restoring depleted soil, forests, or fishing grounds is very costly

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Level IV

BD (2E,50;NI,81;TI,95)

- Knows that life is adapted to conditions on earth, including the strength of gravity to hold an adequate atmosphere and an intensity of radiation from the sun that allows water to cycle between liquid and vapor

BD (2E,51;NE,84)

- Knows that weather (in the short run) and climate (in the long run) involve the transfer of energy in and out of the atmosphere

BD (2E,51;NE,83-85;TI,92)

- Knows that solar radiation heats the land masses, oceans, and air and that transfer of heat energy at the boundaries results in layers at different temperatures and densities in both the ocean and atmosphere; as layers of heat energy rise and fall, they produce winds and ocean currents

BD (2E,51;NI,86;TI,84)

- Knows that solar radiation--direct and through the winds and rivers it creates on the earth's surface--is continually available, and can be transformed into electrical energy, which is then distributed widely for lighting, heating, and running machinery

BD (2E,51;DI,14.3)

- Knows that solar energy is stored in plants as chemical energy that can be transformed to other forms of energy or used for food

BD (2E,51;NI,80;TI,80;DI,14.4)

- Knows that energy storage in ancient plants is still available to us in fossil fuels, which provide a convenient, transportable fuel for vehicles

(2E,51;NI,57;TE,80)

6. Understands the processes that shape the surface of the earth and the relation of the surface of the earth to the living environment

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Level I

BD (2E,52;NI,57-58)

- Knows that rocks come in all sizes, from boulders to grains of sand

BD (2E,52)

- Knows that change is something that happens to many things around us

BD (2E,52;TE,48)

- Knows that living things respond to the conditions around them, and they can sometimes change their surroundings

Level II

BD (2E,52;NE,60)

- Knows that waves, wind, water, and ice change the earth's surface to produce many of the landforms, such as shorelines, cliffs, deserts, and valleys (wind and water can move soil, depositing it downstream in seasonal layers)

BD (2E,52;NI,57)

- Knows that smaller rocks come from the breakage and weathering of larger rocks

BD (2E,52;NE,58)

- Knows that soil is made partly from weathered rock and partly from products of plants and animals

BD (2E,52;NI,57-58)

- Knows that heating and movement within the earth cause earthquakes and volcanos and create mountains and ocean basins

BD (2E,52;NI,65)

- Knows that some geologic changes happen slowly, others rapidly; for example, the earth's surface is shaped in part by the motion of water and wind over very long periods of time and volcanoes can quickly alter land formations

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Level III

BD (2E,53;NE,79;TE,81)

- Knows that sediments of sand and dead organisms are gradually buried, subjected to great pressure from the weight of the overlying materials, and eventually may be turned into rock again: re-formed rock layers may be forced up again to become land surface and even mountains

BD (2E,53;NE,66;TE,80;DI,15.3)

- Knows that thousands of layers of sedimentary rock confirm the long history of the earth, and the long history of changing life forms whose remains are found in successive layers of sedimentary rock

BD (2E,53;NE,66;TE,85)

- Knows that the composition and texture of the soil and its fertility and resistance to erosion are greatly influenced by plant roots and debris, bacteria, fungi, worms, rodents, and other animals, as they break up the soil and add organic material to it

Level IV

BD (2E,53;NI,77;TI,96)

- Knows that plants alter the earth's atmosphere by removing carbon dioxide from it, using the carbon to make sugars, and releasing oxygen -- a process that originated and maintains the presence of oxygen in the air

BD (2E,54;NE,80;TE,86,93;DI,28.4)

- Knows that the solid crust of the earth -- including both the continents and the ocean basins--consists of separate plates that float on an almost molten layer of the earth and which can slowly fold, forming mountain ranges; separate under continents, sinking to form valleys; slide under one another, or collide, generating earthquakes at the boundaries; and that volcanic eruptions release molten rock from below helping to build up mountains; undersea activity spreads ocean floors and may form undersea mountains and ocean islands

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(2E,54;CE,41;NE,91;SE,21;TE,61)

7. Understands basic concepts about the structure of matter

Level I

BD (2I,55;CE,41;SE,27)

- Knows that all objects occupy space and have mass

BD (2E,56;CE,41;NE,91;SE,27)

- Knows that objects can be described and classified by their composition (wood, metal, etc.) and their physical properties (color, size, shape)

Level II

BD (2I,48;CE,42;NI,92-93;SE,27;TE,67,103)

- Knows that materials can exist in different states (solid, liquid, gaseous), each having characteristic properties

BD (2E,56;CE,46;SE,27;TI,61-62)

- Knows that some properties of a material may be changed by external actions like heating and cooling, but different materials respond differently to the same actions

BD (2E,56;CE,43;NE,109;SE,29;TI,62)

- Knows that when a new material is made by combining two or more materials, as in a chemical transformation, the material can have properties that are different from the original materials

BD (2E,56;CE,43;NE,92;SE,27;TE,61,68)

- Knows that the mass of a material is conserved whether it is together or in parts, or in a different state

Level III

BD (2E,58;CE,43;NE,98;SE,29;TE,64)

- Knows that experimental evidence supports a particulate model of matter, e.g., that matter is made up of microscopic particles called atoms

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BD (2E,57;CE,43;NE,65;TE,64)

- Knows that there are about 100 elements -- substances that are made of only one kind of atom, different from the atoms of any other element -- and that elements are seldom found in their pure form

BD (2I,58;CE,43;NE,99;SE,29;TE,66)

- Knows that particles (atoms) in solids are close together, and don't move about easily; in liquids, particles are close together and stick to each other, but move about easily; particles in gas are quite far apart and move about freely

BD (2I,58;CE,43;SI,35;TE,64,66)

- Knows that atoms often combine to form a molecule (or crystal), the smallest particle of a substance that retains its properties

BD (SE,36;NI,98,100;TE,64,67)

- Knows that matter is composed of elements, compounds (the combination of two or more elements) and numerous mixtures of these two kinds of substances

BD (CE,43;NE,98;TE,61)

- Knows methods used to separate mixtures into their component parts (boiling, filtering, chromatography, screening)

BD (2E,58;CI,43;NI,99;SI,29;TI,66)

- Knows that an enormous variety of biological, chemical, and physical phenomena can be explained by changes in the arrangement and motion of atoms and molecules

BD (2E,58;CI,50;SI,29;TE,61)

- Understands that no matter how substances within a closed system interact with one another, or how they combine or break apart, the total weight of the system remains the same; the same number of atoms weigh the same, no matter how they are arranged

BD (SE,29;TE,72,111)

- Knows that a change in either the pressure, temperature, or volume of a gas sample results in measurable, predictable changes in either of the other two properties

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Level IV

BD (2E,59;CE,43;TI,70,119)

- Knows that atoms consist of negative electrons, which occupy most of the space in the atom, and very tiny nuclei consisting of neutrons and positive protons, each almost two thousand times heavier than an electron

BD (2I,59;CE,44;NI,107;SE,35;TI,70)

- Knows that the arrangement and number of electrons determine the properties of an element (see the periodic table) and how an atom can interact with other atoms

BD (2E,59;CE,45;SE,35;TI,70)

- Knows that usually the number of electrons will equal the number of protons, and the neutron has no electric charge, so the atom, overall, is electrically neutral

BD (2E,59;CE,45)

- Knows that neutrons have a mass nearly identical to that of protons, have little effect on how an atom interacts with other atoms, but do affect the mass and stability of the nucleus

BD (2E,59;CE,53;NI,112;SE,37;TE,63,69)

- Knows the rate of reactions among atoms and molecules depends on the concentration, pressure, and temperature of the reacting materials and a suitable catalyst

BD (2E,59;CE,46;SE,36;TE,70)

- Understands that radioactive atoms are isotopes in which the nucleus is unstable and spontaneously decays, emitting particles or wave-like radiation at a characteristic rate

BD (2E,59;CE,46;SI,35;TE,66,70)

- The properties of a molecule are determined by the number and types of atoms it contains and how they are arranged

BD (2E,59)

- Knows that shapes are particularly important in how large molecules interact with others

BD (2E,59;CE,44)

- Knows that scientists continue to investigate atoms and have discovered even smaller constituents of which electrons, neutrons, and protons are made

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BD (SE,36;TE,67)

- Knows that substances can be represented by formulas or three-dimensional models showing the number, types, and/or relative positions of the atoms that make up the substance

(2E,60;CE,61;NE,94;SE,21;TE,105)

8. Knows the forms energy takes, its transformations from one form to another, and its relationship to matter

Level I

BD (CI,61;NE,62,95;SE,23)

- Knows that the sun applies heat and light to earth

BD (CE,68;NI,95;SE,23;TE,114)

- Knows that an energy source, like a battery within a circuit, can produce light, sound and heat

BD (CI,73;NI,97;SE,23)

- Knows that an object in a beam of light can cast a shadow, while other objects might bend or transmit the light

Level II

BD (2E,62;CI,73;SE,30)

- Knows that things that give off light often give off heat

BD (2E,62;CI,61;NI,94-95;SE,30)

- Knows that mechanical and electrical machines give off heat

BD (2E,62;CE,67;TE,65;107)

- Knows that when warmer things are put with cooler ones, the warm ones lose heat and the cool ones gain it until they are all at the same temperature

Level III

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BD (2E,63;CE,62;NE,100-101;SE,29;TI,105)

- Knows that energy comes in different forms, such as light, thermal, electrical, kinetic (motion), and sound, which can be changed from one form to another

BD (2E,63;NE,101;SE,35;TE,65)

- Understands that whenever the amount of energy in one place or form diminishes, the amount in other places or forms increases by the same amount

BD (SE,29;TI,114)

- Knows that temperature changes in a sample of matter are related to the loss or gain of thermal energy by the sample

BD (CE,62;SE,30;TE,65)

- Knows that energy comes to the earth from the sun as visible light and electromagnetic radiation; the amount and type of radiation depend upon the absorption properties of the atmosphere

BD (CE;75;SE,30;TE,65)

- Knows that energy changes involved in physical or chemical changes can be measured in the form of heat

BD (SE,35;TE,106)

- Knows that energy can be harnessed to do work, which is represented by the quantity of force applied to an object times the distance the object moves in the direction of force

Level IV

BD (2E,63;CE,64;TE,121)

- Knows that heat energy in a material consists of the disordered motions of its colliding atoms or molecules

BD (2E,63;CE,66;SE,36;TI,119)

- Knows that any interactions of atoms or molecules involve either a net decrease in potential energy or a net increase in disorder (entropy), or both

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BD (2E,63;CE,66;NE,110;SE,36;TI,114)

- Knows that transformations of energy usually produce some energy in the form of heat, which by radiation or conduction spreads into cooler places, so that less can be done with the total energy

BD (2E,63;CI,62;SI,36)

- Knows that characteristic energy levels associated with different configurations of atoms and molecules means that light emitted or absorbed during energy transformations can be used to provide evidence regarding the structure and composition of matter

BD (2E,63;CE,47;TI,119,121)

- Knows that some changes of atomic or molecular configuration require an input of energy, whereas others release energy

BD (2E,63;CE,52;SE,36-37;TE,120)

- Knows that the difference in the strength of forces involved in nuclear particles and those associated with molecules are reflected in the differences in energy released in nuclear and chemical reactions

BD (2E,64;TE,121)

- Knows that energy transformations occur whenever the nuclei of very heavy atoms, such as uranium or plutonium, split into middle-weight ones, or when very light nuclei, such as those of hydrogen and helium, combine into heavier ones

(2E,65;CE,53;NE,96;SE,37;TE,104)

9. Understands motion and the principles that explain it

Level I

BD (2E,67;CE,53;NI,97;SE,24)

- Knows that the varieties of motion include straight line, zigzag, vibrational, or circular

BD (2E,67;CE,55;SE,24)

- Knows that an object's motion can be changed by a push or a pull by people, or by other objects

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BD (2E,67;CE,75,SE,24)

- Knows that things that make sound vibrate

Level II

BD (2E,67)

- Knows that how fast things move varies greatly; some things are so slow that their journey takes a long time, while others move too fast for us to even see them

BD (2E,67;CE,56;NE,96;SE,24)

- Knows that when a force is applied to an object, the object either speeds up, or slows down, or goes in a different direction

BD (CE,54;NE,96;SE,24)

- Knows that motion can be described as change in position with time, and can be represented on grids or graphs

BD (2E,67;CE,56;NI,104;SI,35)

- Knows that the greater the force that is applied to an object, the greater the change in motion the object will have, and the heavier the object is, the smaller the effect a given force will have

BD (SE,24;NI,104;TI,110)

- Knows that properties of sound such as pitch and loudness can be altered by changing the properties of its source (a vibrating object)

BD (2E,68;CI,73;SE,30d)

- Knows that light from the sun is made up of a mixture of many different colors of light, even though to the eye the light looks almost white

Level III

BD (2E,68;CE,57;NE,103-104;SE,30;TE,104-105)

- Knows that whenever an object is seen to speed up, slow down, or change direction, we know that an unbalanced force (e.g., friction) acts on it

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BD (2E,68;CE,76;NE,97,104;TI,109)

- Knows that vibrations (e.g., sound and earthquakes) move at different speeds in materials and have different wavelengths, and set up wave-like disturbances that spread away from the source

BD (2E,68;CE,62;NI,113;SE,35;TI,121,124)

- Knows that a great variety of radiations are electromagnetic waves: radio waves (the longest), microwaves, radiant heat, visible light, ultraviolet radiation, x-rays, and gamma rays (the shortest), which all move at a fixed speed (the speed of light) in a vacuum

BD (CE,74;NE,113;SE,30;TI,116-117)

- Knows that light, which has color, brightness and direction associated with it, can be absorbed, scattered, reflected or transmitted by intervening matter: understands the concepts of opacity, and of refraction as the basis for the operation of lenses and prisms

BD (SE,30;TE,105)

- Knows that changes in motion of an object which also have magnitude and direction, are caused by forces

BD (SE,30;NI,103;TI,112)

- Knows that an object's motion can be described and represented graphically in terms of direction, speed, velocity, and position vs. time

Level IV

BD (2E,69;CE,59;NI,111;SE,37;TI,112)

- Knows that the rate of change in the motion of an object is directly proportional to the applied force and inversely proportional to the mass; the relationship between force and acceleration is described by F=ma

BD (21,69;CE,56-57;NI,111;SE,37;TE,104;DI,24.3)

- Knows that unless acted upon by an outside force, an object at rest tends to stay at rest and an object in motion tends to stay at constant momentum; since all motion is relative to a frame of reference, no experiment can distinguish 'rest' from 'motion'

BD (2E,55;NI,111-112;SE,37;TE,120)

- Knows that all forces have magnitude and direction; forces acting in the same direction reinforce each other; forces acting in different directions cancel each other

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BD (2E,69;CE,56;NE,104;SE,37;TI,120)

- Knows that whenever one thing exerts a force on another, an equal force and opposite force is exerted back on it

BD (SE,37;TE,112)

- Knows that motion can take place in two or three dimensions

BD (SE,37;TI,120)

- Knows that an object's motion can be described in terms of velocity or acceleration, and can be represented in various ways, including distance-time and speed-time graphs, as well as through mathematical equations and vectors

BD (SE,37;TE,113)

- Knows that constant motion in a circle requires a force to maintain it

BD (2I,69;CE,54;NI,113;SE,35;TI,109)

- Knows that waves (such as electromagnetic waves and sound waves) have wavelength, amplitude, frequency and characteristic speed, can be used to transmit signals or energy without the transport of matter, and that electromagnetic waves can be transmitted through a vacuum

BD (2E,69;CE,78;NE,112;TE,112,124)

- Knows that apparent changes in wavelength can provide information about changes in motion

BD (2E,70)

- Knows that wave effects vary with wavelength

BD (2E,70;CE,47;NI,109-110;SI,35)

- Knows that the energy of waves (electromagnetic and material) can be changed into other forms of energy (e.g., chemical and electrical), just as other forms of energy (chemical and nuclear) can be transformed into wave energy

BD (2E,69;TE,124)

- Understands that the observed wavelength of a wave depends upon the relative motion of the source and the observer; if either the source or observer is moving toward the other, the observed wavelength is shorter; if either is moving away, the wavelength is longer

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BD (2E,69;TE,97-98,124)

- Knows that because the light we see from almost all distant galaxies has longer wavelengths than the same light here on earth, astronomers believe that the whole universe is expanding

BD (2E,70;TI,116-117)

- Knows that waves can superpose on one another, bend around corners, reflect off of surfaces (echo), be absorbed by materials they enter, and change direction when entering a new material

(2E,70;NI,96;TI,104)

10. Knows the kinds of forces that exist between objects and within atoms

Level I

BD (2E,71;CE,55;TE,96)

- Knows that things near the earth fall to the ground unless something holds them up

BD (2E,71;CE,68)

- Knows that by using magnets, we can make things move, stop, or move in a different direction

Level II

BD (2E,71;CE,55;NI,76;TE,96;DE,5.3)

- Knows that things near the earth are pulled towards it by gravity

BD (2E,71;CE,68;NI,93)

- Knows that a magnet can pull or push other magnets without touching

BD (2E,71;CE,68;TE,107)

- Knows that material that has been electrically charged by rubbing can attract and repel other materials

Level III

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BD (2E,71;CE,55)

- Knows that every object exerts gravitational force on every other object, a force that depends on the mass of the objects and their distance from each other

BD (2E,71;CE,55)

- Knows that the gravitational force is very weak unless at least one of the objects (e.g., the earth) has a lot of mass

BD (2E,72;CE,55;NI,76,78)

- Knows that the sun's gravitational pull keeps the earth and other planets in their orbits, just as the planets' gravitational pull keeps their moons in orbit around them

BD (2I,72;CE,69;NE,100;SE,30;TE,108,123)

- Knows that just as electric current can produce magnetic forces, magnets can cause electric currents

Level IV

BD (2E,72;CE,58;NI,111)

- Knows that gravitational force is thought of as an attraction between masses

BD (2E,72;SE,36;TI,119)

- Knows that electromagnetic forces acting within and between atoms are vastly stronger than the gravitational forces acting between them

BD (2E,72;CE,45;SE,36;TI,75,120)

- Knows that at the atomic level, electric forces between oppositely charged electrons and protons hold atoms and molecules together and thus are involved in all chemical reactions; on a larger scale electric forces hold solid and liquid materials together and act between objects when they are in contact

BD (2E,72;CE,48;SI,36;TE,68,107)

- Knows that different kinds of materials respond differently to electric forces; insulators, conductors, superconductors and semiconductors

BD (2E,72;CE,70;NI,109;TE,115,121)

- Knows that magnetic forces are very closely related to electric forces and can be thought of as different aspects of a single electromagnetic force: moving electric charges produce

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magnetic forces and moving magnets produce electric forces; the interplay of these forces is the basis for electric motors, generators, radio, television and many other modern technologies

BD (2E,72;NI,109;SI,36;TE,72,119)

- Knows that the forces that hold the nucleus of atoms together are much stronger than the electromagnetic force; this explains why great amounts of energy are released from the nuclear reactions in atomic or hydrogen bombs, and in the sun and other stars

(2E,75;NE,115;SI,42;TI,47)

11. Knows about the diversity and unity that characterize life

Level I

BD (2E,77;SE,43)

- Knows that some animals and plants are similar in appearance and behavior, and others are very different from one another

BD (2E,77)

- Knows that stories sometimes give plants and animals attributes they really do not have

Level II

BD (2E,77;CI,119;NI,115;SE,43)

- Knows that living things can be sorted into groups in many ways using various properties to decide which things belong to which group

BD (CE,118;NE,118;SE,43;TE,48)

- Knows that plants and animals are alive and go through predictable life cycles, which include growth, development, reproduction and death

Level III

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BD (2I,78;CE,122;NI,119;SE,45;TI,53)

- Knows that major categories of living organisms are plants, which get their energy directly from sunlight; animals, which consume energy-rich foods; and microorganisms, some kinds of which cannot be neatly classified as either plants or animals

BD (2E,78;NI,118,121,128;SE,46;TI,47)

- Knows that organisms can be classified according to the function they serve in a food chain (producer, consumer and/or decomposer of organic matter) and by the details of their internal and external features

BD (2E,78;DI,14.3)

- Knows that all organisms, including the human species, are part of and depend on two main global food webs: one global food web starts with microscopic ocean plants and seaweed, then to the animals that feed on them, and finally the animals that feed on those animals; the other global food web begins with land plants and includes the animals that feed on them, and so forth

BD (SE,46;NE,122)

- Knows that there are minor differences among individuals from the same population or among individuals of the same kind (species); some differences are acquired by the individual and affect only that individual while other differences can be passed on to the individual's offspring

Level IV

BD (2E,78;CE,127,SE,51)

- Knows that the diversity of organisms within a species increases the likelihood that at least some members of the species will survive under changed conditions, and that the diversity of species themselves increases the chances that at least some varieties of living things will survive a catastrophic disturbance

BD (2E,79;CE,120)

- Knows that the similarity of organisms inferred from similarity in their molecular structure closely matches the classification based on anatomical similarities

BD (2E,79;CI,123)

- Knows that the degree of kinship between organisms or species can be estimated from the similarity of their DNA sequences

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(2E,79;NI,115;TI,47)

12. Understands the genetic basis for the transfer of biological characteristics from one generation to the next

Level I

BD (2E,80;CE,128;NI,116;SE,43)

- Knows that offspring grow up to be similar to their parents

Level II

BD (2E,80;CI,128;NI,116;SI,43)

- Knows that animals take some features from one parent, other features from the other parent, and some from both, or that sometimes offspring inherit features that seem to be more like those of its grandparents and its parents

BD (2E,80;CI,129;SE,45)

- Understands that small differences between parents and their offspring can accumulate, so descendants can be very different from their ancestors

Level III

BD (2E,80;CE,128;NI,124;SE,45;TE,48,52)

- Knows that in sexually-reproducing organisms, half of the genes come from each parent, whereas in asexually-producing organisms, all the genes come from a single parent

BD (2E,80;CE,128;NE,132;SE,45;TI,52)

- Knows that in sexual reproduction, a single specialized cell from a female merges with a specialized cell from a male, and that as the fertilized egg, carrying an unpredictable half of genetic information from each parent, multiplies millions of times to form the complete organism, the same genetic information is copied in each cell

BD (2E,81;CE,128;NI,122;SE,45;TI,52)

- Understands that the sorting and combination of genes in sexual reproduction results in a great variety of possible gene combinations from the offspring of any two parents

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Level IV

BD (2I,81;SE,50;TI,52)

- Knows that genes, the sub-units of cell components called chromosomes, convey encoded information directing the synthesis of a cell product, and can often be identified with a trait observed in the organism

BD (2E,81;NE,131;SE,50;TE,55)

- Knows that genetic instructions, which are almost identical in each cell's descendants, are encoded in DNA, and can produce different types of cells by using different parts of the instructions, the part of the genetic instructions used depending on a cell's immediate environment

BD (2E,81;CE,129;NI,128-129;SE,50;TI,55)

- Knows that genes are segments of DNA molecules, and that inserting, deleting, or substituting portions of the DNA can alter genes; changes in DNA (mutations) can also occur when a cell is exposed to certain kinds of radiation or chemical substances

BD (2E,81;CI,129;SE,50;DI,12.4,15.4)

- Knows that if an altered gene is in a sex cell, it may be passed on to offspring; if change occurs in another cell, it is passed on only to the products of that cell

BD (2E,81;CE,129)

- Knows that features resulting from an altered gene may help, harm, or have little effect on the offspring's success in its environment

BD (SE,50)

- Knows that fragments of DNA can be analyzed to identify the individual from which the sample of DNA came, diagnose human genetic abnormalities, and to study populations

(2E,81;NE,117;TE,47)

13. Knows the general structure and functions of cells in organisms

Level I

BD (2E,82;CE,116;NE,119;SE,43)

- Knows that most plants and animals need air, food and water

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BD (2I,83;CE,116;NI,116;SE,43)

- Knows that plants and animals are composed of different parts, serving different purposes and contributing to the well-being of the whole organism

BD (2E,82;DI,2.1)

- Understands that magnifiers can let us see things that we don't expect

Level II

BD (2E,82;CI,118;TI,47;DI,32.1)

- Knows that tiny living creatures exist that we usually can see only through a microscope

BD (2E,83;CI,118)

- Knows that some living things, like sponges, are made of a few layers of similar cells that play slightly different roles and that benefit from cooperating

Level III

BD (2E,83;CE,116;NE,132;SE,46;TI,51)

- Knows that all living things are composed of cells from one to many millions; cells are the smallest unit of life that can reproduce themselves

BD (2E,84;CE,116;SE,46;TE,51)

- Knows that cells can differ in many ways, assuming different appearances and carrying out specialized functions, making up different body tissues and organs

BD (2E,83;CE,116;NE,131;SE,46;TE,47)

- Knows that cells contain a common set of observable structures (membrane, nucleus and other organelles) that have different functions, including conversion and use of energy, protection and reproduction

BD (SE,46;NI,124;TI,52)

- Knows that cell replication results not only in the multiplication of individual cells, but also in the growth and repair of multicellular organisms

BD (SE,47;NI,132;TE,51)

- Knows that complex multicellular organisms are interacting systems of cells, tissues or organs that fulfill life processes through mechanical and chemical means (including

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procuring or manufacturing food; breathing and respiration; excreting waste products of metabolism; reproducing; protecting against disease; supporting structures and movement; controlling body functions; providing information about events within the body and in the organism's surroundings)

Level IV

BD (SE,49;NI,131-132;TI,51)

- Knows that many molecular aspects of life processes of multicellular organisms occur in cells; cells are the sites of chemical syntheses and energy conversions essential to life

BD (SE,49;NE,131;TE,53)

- Knows that cells are highly organized collections of chemical substances; the fundamental chemical substances of life are long chains of carbon atoms with differing functional groups, including carbohydrates, lipids, proteins and nucleic acids

BD (2E,84;CE,127;NI,131;SE,49;TI,51)

- Knows that every cell is covered by a membrane that controls what molecules can enter and leave the cell; inside the cell are specialized parts for transport of materials, energy release, protein building, waste disposal, information feedback, and movement

BD (2E,84;NE,132;SE,49)

- Knows that in complex multi-cellular systems, cells communicate with each other, and are mutually dependent; cell behavior can be affected by molecules from other parts of the organism, or even other organisms

BD (2E,84;CE,129;NE,131;SE,49;TE,55)

- Knows that DNA molecules in each cell carry coded instructions for building protein molecules that form the structures and control the functions within cells; information about the nature of the substances synthesized is carried to the site of the synthesis by a form of RNA

BD (2E,84;CE,129)

- Knows that proteins are long, usually folded chain molecules made from 20 different kinds of smaller amino acid molecules; the function of each molecule depends on the sequence of amino acids in it and the shape of the chain

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BD (2E,84;SE,49;TI,53)

- Knows that complex interactions among the different kinds of molecules in the cell cause distinct activities, such as growth and division; each metabolic event consists of many chemical reactions, each catalyzed by a specific enzyme

BD (SE,49;NI,131)

- Knows that the complexity of energy conversions in cells is a necessary adaptation of living organisms to avoid the otherwise violent nature of energy conversions, as they are seen to occur in vitro

BD (2E,84;CE,127;TI,55)

- Knows that exposure of cells to certain chemicals and radiation increases mutations and thus increases chances of cancer, a gene mutation that results in uncontrolled cell division

BD (2E,84)

- Knows that the DNA codes used for making proteins are nearly the same for all living things

BD (2E,84;DI,11.4,15.4)

- Knows that when mutations occur in reproductive cells, the changes in genetic information can be passed on to successive generations

(2E,84;NE,119;TE,48)

14. Understands how species depend on one another and on the environment for survival

Level I

BD (2E,85;SI,43)

- Knows that animals eat plants or other animals for food and may also use plants for shelter and nesting

Level II

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BD (2I,85;CE,127;SE,43;TE,48,56)

- Knows that all organisms, including invisible organisms like bacteria, need their environments, are influenced by environmental forces and also influence the environment to some extent

BD (2I,79;CE,136;SE,43)

- Knows that plants and animal species depend on each other to maintain life, e.g., many plants depend on animals for carrying their pollen to other plants or for dispersing their seeds

Level III

BD (2E,86;CE,139;NI,122;SE,46;TE,54)

- Knows that all species ultimately depend on each other; interactions between two types of organisms include producer/consumer, predator/prey, parasite/host, scavenger, decomposer, and relationships that are mutually beneficial

BD (2E,86;CE,137;TE,49)

- Knows that ecosystems can be described as systems in which organisms compete for finite resources, including food, space, light, heat, water, air and shelter

BD (2E,86;CE,137;NI,121-122;SE,46;TE,49-50)

- Knows that the kinds of organisms and the population densities in an ecosystem depend on conditions of the physical environment (e.g., sunshine, precipitation, minerals, range of normal temperature, topography) which were shaped by its geological and biological history

BD (SE,46;NI,126;TI,50)

- Knows that short-term changes in available food, moisture or temperature of an ecosystem may result in a change in the number of organisms in a population, or the average size of an organism; long-term changes may result in the elimination of a population

BD (NE,69;TE,80)

- Knows the physical characteristics of lakes, oceans, rivers, and ground water and their relation to habitats for plant and animal life

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Level IV

BD (2E,86;CE,140;NI,126)

- Knows that the interdependence of organisms helps to stabilize food webs when minor changes in the environment occur, and results in reasonable stability over hundreds of thousands of years

BD (2E,86;CE,139)

- Knows that like many complex systems, ecosystems have cyclic fluctuations around a state of rough equilibrium

BD (2E,86;CE,137)

- Knows that ecosystems always change when climate changes or when very new species appear as a result of migration or evolution (or are introduced deliberately or inadvertently by humans)

BD (2E,86;TI,54)

- Knows that if a disaster such as flood or fire occurs, the damaged ecosystem is likely to recover in stages that yield a system similar to the original one

BD (2E,86;TI,54)

- Knows that as any species proliferates, it is held in check by one or more environmental factors: depletion of food or nesting sites, increased predation, or parasites

(2E,87;TI,49)

15. Understands the cycling of matter and flow of energy through the living environment

Level I

BD (2E,87;CE,116;SE,43)

- Knows that plants and animals both need water, animals need food to eat and plants need light

BD (2E,87;CE,97;SI,45)

- Knows that many materials can be recycled; recycled materials continue to exist, but in another form

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Level II

BD (2E,88;SE,45;SI,43)

- Knows that all animals' food can be traced back to plants

BD (2E,88;CE,116;NE,94;SE,43)

- Knows that some source of "energy" is needed for any work to be done; for example, food is the fuel and the building material for all organisms

Level III

BD (2E,88;CE,116;NE,131;SE,45;TE,54,65;DI,5.4)

- Knows that all food energy ultimately comes from the sun as plants convert light into stored chemical energy; that energy can change from one form to another in living things; that animals get energy from their food (but capture only a small part of the energy)

BD (2E,89;CE,138;NE,135;SE,45;TI,50)

- Knows how matter is cycled and recycled within ecosystems, yet the total amount of matter remains constant, even though its form and location change; that the chemical elements that make up the molecules of living things pass through the food web and are combined and recombined in different ways

BD (2E,88;CE,139;SE,45;DI,10.3)

- Knows how food chains and food webs describe the systems of energy that flow through ecosystems

BD (2E,90;NI,95;SE,49;TI,54)

- Knows that at each link in a food web, some energy is stored in newly-made structures, and some is dissipated into the environment as heat; when energy is dissipated as heat, solar energy must be captured to make up for the loss

BD (SE,47;TE,54)

- Knows that all organisms, whether single or multicellular, exchange materials and energy with their environments

BD (2E,89)

- Knows that over the whole earth, organisms are dying and decaying just as fast as new life is born

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Level IV

BD (2E,89;C1,63;N1,110;D1,5.4)

- Knows that millions of years ago, plants and marine organisms grew faster than decomposers could recycle them, resulting eventually in the stored energy of great coal beds and oil pools; and that the burning of these fossil fuels, rapidly releasing the stored energy back into the environment as heat along with carbon dioxide, has serious implications for our future

BD (2E,89;C1,63;T1,54)

- Knows that the amount of life any environment can support is limited by the available energy, water, oxygen, and materials, and by the ability of ecosystems to recycle the residue of dead organic materials

BD (2E,89,C1,63;N1,134;T1,54)

- Knows that human technology can upset the balance of ecosystems, forcing them to draw on their reserves of living and dead biomass which can result in soil leaching, the enlargement of deserts and other reductions in the fertility of land

BD (SE,49;N1,135;T1,54)

- Knows that biological systems -- cells, multicellular organisms and ecosystems -- obey the same conservation laws as they do in physical systems; the conservation of energy law is a powerful tool for the analysis of metabolic processes in cells and organisms, as well as for the analysis of energy flow in ecosystems

(2E,90;NE,117;TE,56)

16. Understands the basic concepts of the evolution of species

Level I

BD (2E,91;CE,121)

- Knows that some kinds of things that live today still resemble once living things that have completely disappeared

BD (2E,77;CE,118;N1,115;SE,43)

- Knows that plants and animals have features that help them live in different environments

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Level II

BD (2E,91;C1,129;S1,43)

- Knows that living things of the same kind vary among individuals, and sometimes the differences give individuals an important advantage in surviving and reproduction

BD (2E,91;CE,125)

- Knows that cultivated plants and domestic animals result from selective breeding for particular traits

BD (2E,91;CE,130;N1,66)

- Knows that fossils provide evidence that some organisms living long ago are now extinct, and can be compared to one another and to living organisms according to their similarities and differences

Level III

BD (2E,91;CE,137;SE,46)

- Knows that changes in, or limits imposed by environmental conditions can affect the survival of individual organisms and entire species: organisms with certain traits are more likely than others to survive and have offspring

BD (2I,91;CE,135;N1,66;DI,37.3)

- Knows how the fossil record, through geologic evidence, documents the appearance, diversification, and extinction of many life forms

BD (2E,91;CE,132;N1,128;SE,51;T1,56-57)

- Knows that the basic idea of evolution is "descent with modification;" that the earth's present-day life forms have evolved from common ancestors reaching back to the simplest one-cell organisms about three billion years ago

BD (2E,92;N1,77)

- Knows that during the first two billion years, only microorganisms existed, but once cells with nuclei developed about a billion years ago, increasingly complex multicellular organs evolved

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Level IV

BD (2E,93;NE,130;CE,134)

- Knows that the concept of evolution provides a coherent framework for understanding the diversity of life forms and their similarities, the history of life as seen in the fossil record, the interdependence of life forms, and their dependence on the physical environment

BD (2E,93;CE,132;NE,129-130;TI,56)

- Knows that evolution results from natural selection, which incorporates three well-established observations: some variation in heritable characteristics exists within every species, some of these characteristics give individuals an advantage over others in surviving and reproducing, and the advantaged offspring, in turn, are more likely than others to survive and reproduce

BD (2E,93;NI,129-130)

- Knows that heritable characteristics, which can be biochemical and anatomical, largely determine what capabilities an organism will have, how it will behave, and hence how likely it is to survive and reproduce

BD (2E,93;CI,129;NI,129-130;SE,50;DI,11.4,12.4)

- Knows that new heritable characteristics can only result from new combinations of existing genes or from mutations of genes in an organism's sex cells; other changes in an organism cannot be passed on

BD (2E,93;CE,135;NI,129;TE,56)

- Knows that natural selection leads to organisms that are well suited for survival in particular environments, so that when an environment changes, some inherited characteristics become more or less advantageous or neutral, and chance alone can result in characteristics having no survival or reproductive value

BD (2E,93)

- Knows that evolution does not result in long-term progress in some set direction

BD (2E,93;NI,129-130;TI,56)

- Knows that organisms emerged like the growth of a bush in which some branches survive from the beginning with little or no change, some die out altogether, and others branch repeatedly, sometimes giving rise to more complex organisms

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BD (2E,93)

- Knows that evolution builds on what already exists, so the more variety there is, the more there can be in the future

BD (2E,93)

- Knows that molecular evidence substantiates the anatomical evidence for evolution and provides additional details about the sequence in which various lines of descent branched off from one another

(2E,96)

17. Knows the characteristics that distinguish the human species from other organisms

Level I

BD (2E,96)

- Knows that people have different external features (e.g., size and shape; hair, skin, and eye color; facial features) but they are more like one another than like any other animals

BD (2E,97)

- Knows that people tend to live in families and communities where different people have specialized jobs

Level II

BD (2E,97)

- Knows that people have biologically determined reproductive functions and knows that in other species (e.g., insects) functions like defense or food collection may also be biologically determined

BD (2E,97)

- Knows that fossils (or preserved remains) provide evidence of what people were like a very long time ago

BD (2E,97;TE,105)

- Knows that machines help people to see and do things that they could not see or do (at all, or as quickly, or as well) without them

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Level III

BD (2E,98;TE,49)

- Knows that like other animals, humans have body systems for digestion and assimilation of food, for respiration, and for reproduction

BD (2E,98)

- Knows that humans are like other humans in more ways than they are different (e.g., they can reproduce with and receive blood or donated organs from people from anywhere in the world)

BD (2E,98)

- Knows that despite any wide cultural differences, that complex languages, technologies, and arts distinguish human beings from all other species

BD (2E,98)

- Knows that fossil evidence is consistent with the idea that humans evolved from simpler species

BD (2E,98)

- Knows that specialized roles of other species tend to be genetically programmed, whereas humans have a much greater range of social behavior that they can endlessly invent and modify

BD (2E,98)

- Knows that increasingly, the human species uses technology to make up for some of its disadvantages compared to other species (e.g., poorer speed, strength, and sensory acuity)

BD (2E,98)

- Knows that technology, particularly in obtaining food and preventing disease, has dramatically changed how people live and work and has made possible rapid increases in the human population

Level IV

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BD (2E,99)

- Knows that the similarity in the DNA sequence in all human beings and the resulting similarity in humans' cell chemistry and anatomy (as of the brain) identify us as a single species

BD (2E,99)

- Knows that written records enable humans to share and compile great amounts of information (and misinformation)

(2E,99)

18. Understands the main steps in the transformation of a single fertilized cell into a fully-formed human being, and the process of development and aging that follows birth

Level I

BD (2E,100)

- Knows that all animals have offspring, usually with two parents involved

BD (2E,100)

- Knows that pets may be "fixed" to prevent them from producing offspring

BD (2E,100)

- Knows that a human baby grows inside its mother until it is born

BD (2E,100)

- Knows that after birth, a human baby is unable to care for itself; its survival depends (much more so than for other animals) on the care it receives from its mother and/or other adults

Level II

BD (2E,100)

- Knows that it takes about nine months for a human embryo to develop, receiving nourishment from the mother's body; substances the mother takes in affect -- for better or worse -- how well the baby develops

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BD (2E,100)

- Knows that as people get older, they change in what they look like and what they can do

BD (2E,100)

- Knows that humans may live longer than most other animals, but all living things die

BD (2E,100)

- Knows that most normal babies can make speech sounds by their first birthday and sentences by their second

BD (2E,101)

- Knows that people may be physically able to have children before they know how to take care of them

Level III

BD (2E,101)

- Knows that fertilization occurs when sperm cells from a male's testis are deposited near an egg cell from the female ovary, and one of the sperm cells enters the egg cell: a human baby grows from a single fertilized cell and sometimes, by chance or design, a sperm never gets to the egg, or the egg isn't available

BD (2E,101)

- Knows that during the first three months of pregnancy, organs begin to form; during the second three months, all organs and body features develop; and during the last three months, further development and growth occur

BD (2E,101)

- Knows that the developing embryo, and later the newborn infant, encounters many risks due to possible faults in its genes, its mother's inadequate diet, cigarette smoking, or use of alcohol or other drugs, or infection; that poor prenatal and postnatal care may lead to lower physical and mental capacities; that lack of stimulation during development can hinder or even prevent certain aspects of development

BD (2E,101)

- Knows that development from child to adult occurs with somewhat different timing for different individuals, as a function of different genetic factors, different nutrition, and

different histories, and that societies may place different meanings and importance on human developmental stages and on transitions from one to the next

BD (2E,101)

- Knows that mental development in humans occurs throughout the life span, and the body changes as adults age -- muscles and joints become less flexible; bones and muscles lose some mass; energy levels diminish; the senses become less acute; and women stop producing eggs and hence can no longer reproduce (though men continue to produce sperm)

BD (2E,102;NE,125)

- Knows that the life span of humans is influenced by various factors, including sanitation, diet, medical care, gender, genes, and personal health behaviors

Level IV

BD (2E,102;TE,56)

- Knows that following fertilization, cell division produces a small sphere of cells which differentiate in terms of appearance and function, and eventually form the basic tissues of an embryo from which grow all body organs and systems

BD (2E,102)

- Knows that contraception measures may incapacitate sperm, block their way to the egg, prevent the release of eggs, or prevent the fertilized egg from implanting successfully, and the use of technologies to prevent or facilitate pregnancy raises questions of social mores, ethics, religious belief, and even politics

BD (2E,102)

- Knows that whether someone becomes a parent may be influenced by cultural, personal, or biological factors

BD (2E,102)

- Knows that the extraordinarily long period of human development compared to that of other species is related to the prominent role of the brain in human evolution

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(2E,103)

19. Understands the human body as a system of cells with specialized and coordinated functions

Level I

BD (2E,103)

- Understands that the human body has parts that help it seek, find, and take in food (e.g., senses can warn the body about danger, muscles help it to fight, hide, or get away)

BD (2E,103)

- Knows that without a brain, we wouldn't be able to think, and the brain also helps other body parts work properly

Level II

BD (2E,104;CI,50;DE,20.2)

- Knows that by eating food, people obtain energy and materials for body repair and growth

BD (2E,104)

- Knows that skin protects the body from harmful substances and other organisms

BD (2E,104)

- Knows that the brain gets signals from all parts of the body telling what is going on there, and the brain sends signals to parts of the body to influence what they do

Level III

BD (2E,104)

- Knows that organs and organ systems provide cells with basic needs

BD (2E,104)

- Knows that to release the energy stored in food, the food must be digested into molecules; undigested food is eliminated

BD (2E,105)

- Knows that specialized cells identify and destroy germs that live outside the body

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BD (2E,105)

- Knows that hormones are chemical signals from some parts of the body (various glands) that affect other parts (e.g., in responding to danger and regulating the reproductive system)

Level IV

BD (2E,105;NI,133)

- Knows that lungs take in oxygen for the combustion of food and release the carbon dioxide produced; the urinary system disposes of other dissolved waste molecules; and the skin and lungs rid the body of heat energy (which most of the energy in food eventually turns into)

BD (2E,105;NI,133)

- Knows that the immune system provides protection against microscopic agents/organisms that enter the body and against cancer cells that may arise from seemingly normal cells

BD (2E,105;NI,133)

- Knows that the nervous system exerts its influences by electrochemical signals along nerves and from one nerve to the next

BD (2E,105;NI,133)

- Knows that the hormonal system exerts its influences by chemicals that circulate in the blood

BD (2E,105;NI,133)

- Knows that the nervous and hormonal systems also influence each other in coordinating body systems, coordinating cycles in almost all body functions, and in producing and coordinating external actions by which humans cope with changes in their environment

BD (2E,105)

- Knows that some drugs mimic the molecules involved in transmitting nerve or hormone signals, and therefore disturb normal operations of the brain and body

BD (2E,106)

- Knows that the biological urge to reproduce, necessary for any species to survive, is expressed in different ways among human beings, depending strongly on cultural, personal and biological factors

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(2E,109)

20. Understands the conditions necessary for maintaining good physical health and why they are necessary

Level I

BD (2E,110;CE,118)

- Knows that eating the "right kinds" of food and getting enough exercise help people to stay healthy

BD (2E,110;CI,97)

- Knows that some things in the environment and some things people take into their bodies can hurt them

BD (2E,110;CE,125)

- Knows that some diseases are caused by tiny "germs," which may be spread from people who have them, and washing hands with soap and water will reduce the number of germs put into the nose and mouth

Level II

BD (2E,111;CE,50;18.2)

- Knows that food provides "energy" and essential materials, like vitamins and minerals, for growth and repair of body parts

BD (2E,111)

- Knows that tobacco, alcohol, other drugs, and certain "poisons" in the environment (pesticides, lead) can do harm to people and other living things

BD (2E,111)

- Knows that "germs" may cause harm if they enter the body, which has defenses such as tears, saliva, skin, blood cells, and stomach secretions; if the body is healthy, it can fight germs that do get inside

BD (2E,111)

- Knows that some diseases we only "catch" one time; after we've recovered we don't get sick from them again

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BD (2E,100)

- Knows that taking care of our bodies -- through proper diet, rest, exercise, and medical care -- can help us grow up healthy

BD (2E,111)

- Knows that as humans grow up, the amounts and kinds of food and exercise needed by the body may change

Level III

BD (2E,111)

- Knows that the amount of food energy (calories) a person requires varies with body size, age, sex, activity level, and natural body efficiency

BD (2E,111;CE,118;TI,49)

- Knows that regular exercise is important for maintaining a healthy heart/lung system and for maintaining muscle tone and bone strength

BD (2E,111)

- Knows that toxic substances (e.g., tobacco) and some aspects of today's popular diets and behavior may be bad for people's health, though their effects may not show up for many years; changing dietary habits and avoiding toxic substances increases one's chances of living longer

BD (2E,111)

- Knows that viruses, bacteria, fungi, and parasites may infect or inhabit particular tissues, interfering with normal body functions, and that a person can "catch a cold" many times because there are many varieties of "cold" virus that cause similar symptoms

BD (2E,112)

- Knows that white blood cells engulf invaders, produce antibodies that attack them, or mark them for killing by other white cells; the antibodies remain and can fight off subsequent invaders of the same kind

Level IV

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BD (2E,112)

- Knows that the body can sometimes "mistakenly" attack some of its own cells, and some allergic reactions are caused by the body's "mistaken" immune responses to environmental substances

BD (2E,112)

- Knows that body parts or systems may work poorly for entirely internal reasons, such as faulty genes: some genetic diseases become evident only when an individual has inherited a certain faulty gene from both parents (who may never have shown signs of the disease themselves)

BD (2E,112)

- Knows that the environment may contain dangerous levels of substances that can be harmful to humans

BD (2E,112)

- Knows that new medical techniques, efficient health care delivery systems, improved sanitation, and a fuller understanding of the nature of disease give today's humans a better chance of staying healthy than their forebearers had

BD (2E,112)

- Knows that most people now live in conditions that are very different from the conditions under which the species evolved; some of the differences may not be good for health

(2E,113)

21. Understands some aspects of good mental health and the conditions that promote it

Level I

BD (2E,113)

- Knows that people have many different feelings -- some pleasant, some unpleasant, some perhaps neither -- about themselves and other people

BD (2E,113)

- Knows that different people react to personal problems in different ways; some ways are more helpful than others

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BD (2E,113)

- Knows that talking to someone (a friend, parent, teacher, or counselor) may help people figure out their feelings and problems, and what to do about them

Level II

BD (2E,114)

- Knows that not only do different people handle their feelings differently, but sometimes they have different feelings, even in the same situation

BD (2E,114)

- Knows that often people don't understand why other people act the way they do; sometimes people don't understand their own behavior and feelings

BD (2E,114)

- Knows that people's physical health can sometimes affect their emotional well-being and vice versa

BD (2E,114)

- Knows that one thing people do when they experience a strong feeling -- whether pleasant or unpleasant -- is to think about what caused it, and then consider whether to seek out or avoid similar situations

Level III

BD (2E,114)

- Knows that individuals differ greatly in their ability to cope with stressful situations; often people react to mental distress by denying that they have any problem

BD (2E,114)

- Knows that both outside conditions and internal conditions (chemical, history, values) influence how people feel and behave; sometimes people don't know why they feel the way they do, and some forms of treatment help them uncover the reasons

BD (2E,114)

- Knows that psychological distress has chemical effects in the body and may cause, or increase vulnerability to, biological disease

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BD (2E,115)

- Knows that social contacts and support may help an individual to cope with the effects of mental stresses and to resist certain dangerous activities

Level IV

BD (2E,115)

- Knows that stresses in childhood may be especially difficult to deal with and may have long-lasting effects

BD (2E,115)

- Knows that biological abnormalities -- brain injuries, chemical imbalances -- can cause (or increase susceptibility to) psychological disturbances

BD (2E,115)

- Knows that reactions of other people to an individual's mental disturbance may increase the disturbance

BD (2E,115)

- Knows that people differ greatly in the ways in which they attempt to cope with emotions

BD (2E,115)

- Knows that ideas about what constitutes good mental health and proper treatment for abnormal mental states vary from one culture to another and from one time period to another

(2E,202)

22. Knows the main features of the Copernican Revolution

Level I

BD (2E,203;DI,4.1)

- Knows that during the day, the sun seems to move across the sky; it rises and sets at slightly different times each day

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BD (2E,203;DI,4.1)

- Knows that at night, the moon moves across the sky, and the stars appear to form sort of a dome over the earth

Level II

BD (2E,203;TE,84)

- Knows that a few "stars" called planets, over time appear to change their position in the sky relative to the general pattern of stars

Level III

BD (2E,203)

- Knows that the apparent size of an object on earth or in the sky depends on its distance from the observer, as well as on its actual size, and the apparent motion of an object depends on the motion of the observer as well as on its own motion

BD (2E,203;DI,8.4)

- Knows that the motion of an object is always judged with respect to some other object or point, and so the idea of absolute motion or rest is misleading

BD (2E,204)

- Knows that telescopes magnify some objects in the sky, but not others, and they reveal that there are many more stars in the night sky than are evident by the unaided eye

BD (2E,204;TI,81,89)

- Knows that the surface of the moon has many craters and mountains, the sun has dark spots, and Jupiter and some other planets have moons

Level IV

BD (2E,204)

- Knows that our senses tell us that the earth is large and stationary and that all other objects in the sky orbit around it; those "facts" were the basis for theories of how the universe is organized that prevailed for over 2000 years, from the time of Aristotle

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BD (2E,204)

- Knows that Ptolemy, an Egyptian astronomer living in the second century, devised a powerful mathematical model of the universe based on perfect circles, and circles on circles, that was able to predict the motions of the sun, moon, and stars, and even of the irregular "wandering stars" now known as planets

BD (2E,204)

- Knows that in the sixteenth century, the Polish astronomer Copernicus suggested that all those same motions could be explained by imagining that the earth was spinning and rotating around the sun, an idea that was rejected because it violated common sense, required the universe to be enormous, and, worst of all, removed the earth from the center of the universe

BD (2E,205)

- Knows that Johannes Kepler, a German astronomer who lived at the same time as Galileo, showed that mathematically the ideas of Copernicus made sense if the idea of circular motion was discarded along with that of a stationary earth

BD (2E,205)

- Knows that Galileo used the newly-invented telescope to study the moon, sun, planets, and stars and made many discoveries that supported the ideas of Copernicus, including the planets of Jupiter, sunspots, craters and mountains on the moon, and many more stars than were visible to the unaided eye

BD (2E,205)

- Knows that writing in Italian, rather than Latin (the language of scholars at the time), Galileo presented the arguments for and against the two main views of the universe to the educated people (in a way that favored the newer view) and helped create public controversy on the issue

(2E,205)

23. Knows essential ideas of Newton's conception of the universe and the impact it had on all of science and human thought

Level IV

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BD (2E,205;DI,1.4)

- Knows that Isaac Newton created a unified view of the world in which motion everywhere in the universe -- from objects on earth and the earth itself, to the most distant stars and galaxies -- follows the same few simple rules

BD (2E,205;TE,112,120)

- Knows that Newton's system was based on the concepts of mass, momentum, acceleration, and force, the three laws of motion, and a mathematical law stating that the force of gravity between any two objects in the universe depends only upon their masses and the distance between them

BD (2E,205;NI,88)

- Knows that the Newtonian formulation made it possible to account for such diverse phenomena as tides, the orbits of planets and moons, the motion of falling objects, and the earth's equatorial bulge

BD (2E,205)

- Knows that Newton's science was accepted because it explained so many different phenomena, could be used to predict many physical events (such as the appearance of Halley's comet), was mathematically rigorous, and had many practical applications

BD (2E,205)

- Knows that, although modified in the twentieth century, Newton's ideas have persisted and are still widely used

BD (2E,205)

- Knows that Newton's influence extended far beyond physics and astronomy, serving as a model for other sciences and raising fundamental philosophical questions about such issues as free will and the organization of social systems

(2E,206)

24. Knows basic facts about the ideas of Albert Einstein that extended the Newtonian view of the universe by uniting matter and energy and linking time with space

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BD (2E,207)

- Knows that as a young man Albert Einstein formulated the special theory of relativity, which made revolutionary changes in our understanding of nature

BD (2E,207)

- Knows that a decade after Einstein formulated the special theory of relativity, he proposed the general theory of relativity, which, along with Newton's work, ranks as one of the most profound accomplishments of the human mind in all of history

BD (2E,207)

- Knows that among the surprising implications of special relativity are that in contrast to other moving things, the speed of light is the same for all observers, no matter how they or the light source happen to be moving, and that nothing can travel faster than the speed of light

BD (2E,207)

- Knows that the theory of relativity is best known for stating that any form of energy has mass, and that matter itself is a form of energy

BD (2E,207)

- Knows that the famous special relativity equation, E-mc2, holds that the transformation of even a tiny amount of mass will release an enormous amount of energy, since the c2 in the equation stands for the speed of light squared, which is 186,000 miles per second squared

BD (2E,207)

- Knows that general relativity theory argues that Newton's gravitational force is best understood as a distortion of space and time (rather than something entirely separate)

BD (2E,207)

- Knows that the general theory of relativity has survived repeated tests of its scientific validity, but the search continues for a still more powerful theory of the architecture of the universe

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(2E,207)

25. Understands how science engendered a dramatic change in the conception of the age of the earth

Level IV

BD (2E,208;NI,64)

- Knows that the earth is now estimated to be about five billion years old, but until the last century, most people believed it was created just a few thousand years ago

BD (2E,208;TI,79)

- Knows that the face of the earth changes slowly due to the effects of moving water, wind, earthquakes, volcanoes, and other natural causes

BD (2E,208)

- Knows that the idea that the earth might be vastly older than most people believed made little headway in science until the publication of Principles of Geology by the English scientist Charles Lyell early in the nineteenth century

BD (2E,208)

- Knows that the impact Charles Lyell's Principles of Geology was due both to the wealth of observations it contained on the patterns of rock layers in mountains and the locations of various kinds of fossils, and to the careful logic he used in drawing inferences from his data

BD (2E,208)

- Knows that in formulating and presenting his theory of biological evolution, Charles Darwin adopted Lyell's belief about the age of the earth and his style of buttressing his argument with vast amounts of evidence

(2E,208;TI,80)

26. Understands the struggle within science over the notion of moving continents and how that notion led to the theory of plate tectonics

Level IV

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BD (2E,209)

- Knows that things may be moving even though they seem not to be

BD (2E,209)

- Knows that it is possible to devise ways to detect the motion of slowly moving objects and to estimate their speed

BD (2E,209;NI,81;TI,80)

- Knows that the idea of continental drift was suggested by the complementary shapes of Africa and South America, but rejected for lack of other evidence and because it seemed absurd that anything as massive as the continents could move

BD (2E,209;NI,81;TE,93)

- Knows that early in the twentieth century, Alfred Wegener, a German scientist, reintroduced the idea of moving continents, pointing to such evidence as the underwater shapes of the continents, the similarity of plants and animals on corresponding parts of Africa and South America, and the increasing separation of Greenland and Europe; nevertheless, very few contemporary scientists adopted his theory

BD (2E,209;TE,93;DI,37.4)

- Knows that the theory of plate tectonics was adopted by the scientific community in the 1960's because by then further evidence had accumulated: the theory was seen to provide an explanation for a diverse array of seemingly unrelated phenomena (volcanoes, earthquakes, the formation of mountain and ocean systems, etc.) and there was a scientifically sound physical explanation of how such movement could occur (convection currents in the molten rock on which the continents float)

(2E,210)

27. Understands the nature of the Chemical Revolution

Level I

BD (2E,210;CI,42;NI,93;SE,23;TE,67)

- Knows that things have properties that can be used to tell them apart and to find out which of them are alike (conductivity, density, solubility)

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BD (2E,210;SE,23)

- Knows that objects that are alike in some ways may be different in others

BD (2E,210;SE,23)

- Knows that it is possible to learn about all kinds of objects by counting or measuring them in different ways and comparing the results

Level II

BD (2E,211)

- Knows that fire -- along with air, earth, and water -- was long believed to be the substance out of which everything else is made; this seems sensible, though no longer believed, because it looks like fire is given off when something burns

BD (2E,211;CE,43;SI,29)

- Knows that people have long believed that most things must be made up of combinations of just a few basic kinds of things; there has not always been agreement, however, on what those basic kinds of things are and how they combine or can be made to combine to make other things: that is the work today of chemistry, materials science and physics

BD (2E,211;CE,43;NI,91,98;SI,29;TI,61)

- Knows that all materials, including invisible gases, have weight, and the same volume of different substances usually have different weights; weight is a particularly useful -- but not the sole -- property of materials that can be found only by careful measurement with instruments

Level III

BD (2E,212;CI,69;NI,98;SI,29)

- Knows that Lavoisier launched a scientific revolution when he successfully tested the concept of conservation of matter by conducting a series of experiments in which he carefully measured all the substances involved in burning, including the gases used and those given off

BD (2E,212;SI,36;TE,63)

- Knows that burning is the same kind of reaction as rusting: both are examples of reactions involving the addition of oxygen to something else

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BD (2E,212)

- Knows that alchemy, an effort to change base metals like lead into gold and to produce an elixir that would enable people to live forever, was practiced for centuries but produced very little understanding of the nature of materials and how they react with one another; although the main purpose of basic chemistry is knowledge for its own sake, it has led to the development of practical new materials undreamed of by the alchemists

Level IV

BD (2E,213)

- Knows that Lavoisier invented a whole new field of science based on a theory of materials, physical laws, and quantitative methods, with the conservation of matter at its core; Lavoisier's system for naming substances and describing their reactions contributed to the rapid growth of chemistry by enabling scientists everywhere to share their findings about chemical reactions with one another without ambiguity

BD (2E,213;SI,36)

- Knows that Dalton's modernization of the ancient Greek ideas of element, atom, compound, and molecule strengthened the new chemistry by providing a physical explanation for chemical behavior that could be expressed in quantitative terms

BD (2E,213;SE,36;TI,64)

- Knows that the advancement of chemistry since the time of Dalton and Lavoisier now makes possible an explanation of the bonding that takes place between atoms during chemical reactions in terms of the inner workings of atoms

BD (SE,36;CE,44;TI,72)

- Knows that chemical change can be explained in terms of rearrangements of atoms, which is made possible by the breaking and forming of chemical bonds

BD (SE,36;CE,51;TE,62-63)

- Knows that chemical reactions can be represented by symbolic or word equations that specify all reactants and products involved

BD (SE,36;TI,63,67,69)

- Knows that chemical reactions can be classified into general types based on the nature of the changes involved (acid-base, oxidation-reduction, precipitation, polymerization)

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BD (SE,36;TE,69)

- Understands that some changes do not proceed to completion, but reach a state of equilibrium

(2E,213;TI,121)

28. Knows about the discovery of radioactivity and the atomic nucleus

Level IV

BD (2E,214)

- Knows that accidental discovery that certain minerals containing the element uranium have the same effect on photographic film as light led to the idea of radioactivity

BD (2E,214)

- Knows that for her work in isolating radium and polonium and other work, Marie Curie was the first scientist ever to win the Nobel prize in two different fields: one in physics, shared with her husband, and later, one in chemistry

BD (2E,214)

- Knows that the Curies made radium available to researchers all over the world, increasing the study of radioactivity and leading to the realization that atoms are not the ultimate particles of matter after all, but instead are made up of smaller parts--a small, dense nucleus that contains protons and neutrons and is surrounded by a cloud of electrons

BD (2E,214;TE,118)

- Knows that Ernest Rutherford, who was born in New Zealand, and his colleagues discovered that the heavy radioactive element uranium spontaneously decays into an atom of helium, which is very light, and into an atom of an element that is no longer uranium, but a somewhat lighter element

BD (2E,214;TI,121)

- Knows that Austrian and German scientists showed that when uranium is bombarded by neutrons, elements are produced that have about half the atomic mass as uranium

BD (2E,214)

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- Knows that Lisa Meitner, an Austrian-born physicist and mathematician, and her nephew, Otto Frisch, were the first to point out that if mass was lost during this process of nuclear fission, then in line with Einstein's special relativity theory, energy would be released

BD (2E,214;TI,121)

- Knows that the Italian-born Enrico Fermi, working with colleagues in the United States, demonstrated that the extra neutrons given off during fission could be used to create a sustained chain reaction in which a prodigious amount of energy was given off

BD (2E,215;TI,121)

- Knows that a massive effort went into developing the technology to create the nuclear fission bombs used over Japan in World War II, and, after the war, to create nuclear fusion weapons and the controlled release of nuclear energy to produce electric power, both of which remain matters of public controversy

(2E,215)

29. Understands the development by Charles Darwin of the revolutionary but powerfully unifying concept of the evolution of species

Level IV

BD (2E,215;TI,95)

- Knows that the scientific issue that led to the development of the concept of species evolution was how to explain the great diversity of living and extinct organisms

BD (2E,215)

- Knows that prior to Charles Darwin, the most widespread belief was that all known species were created at the same time and remained unchanged throughout history, although by Darwin's time some scientists believed, wrongly, that characteristics an individual acquired during its lifetime could be passed on to its offspring, thereby gradually changing the species

BD (2E,215;TI,95)

- Knows that Darwin argued that inherited variations made some individuals more likely to survive and have offspring, that their offspring would inherit and pass on those

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advantages, and that over generations, under the right circumstances, the aggregation of advantages would lead to a new species

BD (2E,216)

- Knows that the quick success of Darwin's Origin of Species, published in the mid-1800s, stemmed from the clear and understandable argument it made, including the comparison of natural selection to the selective breeding of animals in wide use at the time, and from the massive array of biological and fossil evidence assembled in support of the argument

BD (2E,216;TI,52)

- Knows that since the publication of Origin of Species, biological evolution has been supported by the rediscovery of the genetics experiments of the Austrian monk, Gregor Mendel, followed by the identification of genes, the working out of the way in which genes are sorted in reproduction, and the discovery that the genetic code found in DNA is the same for almost all organisms

BD (2E,216)

- Knows that by the beginning of the twentieth century, most scientists had accepted Darwin's basic idea, although even now differences exist within the scientific community on the details of the process and on how rapidly evolution can take place

BD (2E,216)

- Knows that people who reject evolution usually do so not for scientific reasons, but because they do not like some of its implications, such as that humans are related to other animals, or because they believe it violates the biblical account of creation

(2E,216)

30. Understands how germ theory differs from earlier notions about what causes illness and how germs were discovered and linked to disease

Level I

BD (2E,217;DI,12.2)

- Knows that plants and animals exist that are so small that they cannot be seen without the help of special instruments

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BD (2E,217)

- Knows that cleanliness and care in the handling of food help people to keep from getting sick

Level II

BD (2E,217)

- Knows that most microorganisms do not cause disease, and many are beneficial to humans

BD (2E,217)

- Knows that vaccinations protect people from several diseases

Level III

BD (2E,217)

- Knows that throughout history, people have created explanations for disease

BD (2E,217)

- Knows that some held that disease had spiritual causes, but the most persistent biological theory over the centuries was that illness resulted from an imbalance in the body "humors" (sorts of fluids)

BD (2E,217)

- Knows that the introduction of germ theory, due to the work of Louis Pasteur and others in the nineteenth century, led to the modern belief that disease is caused by microorganisms -- bacteria, viruses, yeasts, and parasites

BD (2E,217)

- Knows that changes in health practices have resulted from the acceptance of the germ theory of disease

BD (2E,217;NI,133)

- Knows that the modern approach to disease control emphasizes sanitation, the safe handling of food and water, the pasteurization of milk, quarantine, and antiseptic surgical techniques to prevent harmful germs from entering the body; vaccinations to strengthen the body's immune system; and antibiotics and other products to destroy microorganisms

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BD (2E,218)

- Knows that our present understanding of microorganisms and the nature and control of disease has resulted from the contributions of many investigators in many fields of science

BD (2E,218)

- Knows that today, many exciting careers involve microbiology, including careers in clinical research, engineering, science and medicine

Level IV

BD (2E,218)

- Knows that the improvement of microscope lenses and design in the seventeenth century led to the discovery of microorganisms but not to knowledge of their effects on humans and other organisms

BD (2E,218;NI,133)

- Knows that today, high-power imaging and biotechnology make it possible to investigate how microorganisms cause disease, how the immune system combats them, and how they can be manipulated genetically

BD (2E,218)

- Knows that Pasteur did not set out to discover the cause of disease in humans, but to find out what causes milk and wine to spoil

BD (2E,218)

- Knows that Pasteur proved that spoilage and fermentation occur when microorganisms enter from the air, multiply rapidly, and produce waste products; he also showed that spoilage could be avoided by keeping germs out or by destroying them with heat

BD (2E,218)

- Knows that Pasteur showed that microorganisms were involved in animal disease

BD (2E,218)

- Knows that Pasteur did not actually demonstrate that a particular disease was caused by a particular, identifiable germ

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BD (2E,218)

- Knows that the demonstration that a particular disease was caused by a particular germ was accomplished soon after Pasteur's work, by other investigators who applied clinical research techniques

BD (2E,218)

- Knows that to establish a causal link, clinical research workers had to show that a particular germ was always present in the bodies of persons with a particular disease and not present in persons without the disease, and that healthy persons deliberately infected with the germ came down with the disease

(2E,223)

31. Understands what constitutes a system and how the idea of systems is used in different contexts

Level III

BD (2E,223)

- Knows that in mechanical and electrical systems, a single faulty or mismatched part may cause malfunctioning

BD (2E,223)

- Knows that thinking about things as systems means looking for how every part relates to the others

BD (2E,223)

- Knows that the output from one part of a system (which can include material, energy, or information) can become the input to other parts

BD (2E,223;CI,33)

- Knows that feedback can serve to control what goes on in the system as a whole

BD (2E,225)

- Knows that any system is usually linked to other systems, both internally and externally

BD (2E,225)

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- Knows that a system may be thought of as containing subsystems and as being a subsystem of a larger system

Level IV

BD (2E,225)

- Knows that understanding how things work and designing solutions to problems of almost any kind can be facilitated by systems analysis

BD (2E,225)

- Knows that in defining a system, it is important to specify its boundaries and subsystems, indicate its relation to other systems, and identify what its input and its output are expected to be

BD (2E,225)

- Knows that the feedback of output from some parts of a system to input of other parts can be used to encourage what is going on in a system, discourage it, or reduce its discrepancy from some desired value, thus the stability of a system can be greater when it includes appropriate feedback mechanisms

BD (2E,225)

- Knows that only in very simple systems (and not all of them) is it possible to predict what the result of changing some part or connection will be

(2E,225)

32. Understands the nature of physical, conceptual, and mathematical models and the uses made of them

Level I

BD (2E,226)

- Knows that many of the toys he/she plays with are like real things only in some ways

BD (2E,226)

- Knows that many of the toys he/she plays with are different from real things because they are not the same size, are missing many details, or are not able to do all of the same things

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BD (2E,227)

- Knows that a model of a thing is different from the real thing, but can be used to learn something about what the real thing is like

BD (2E,227)

- Knows that one way to describe something is to say what other things it is like

Level II

BD (2E,227)

- Knows that seeing how a model works after something is done to it, such as changing some of its parts, may suggest how the real thing will work if the same is done to it

BD (2E,227)

- Knows that geometric figures, number sequences, graphs, diagrams, sketches, number lines, maps, and even stories can be used to represent objects, events, and processes in the real world, although these representations can never be exact in every detail

Level III

BD (2E,228)

- Knows that models are used to study processes that happen very slowly (like erosion and reproductive cycles, for instance), are too vast to be manipulated (climate and ocean currents), or are dangerous (car crashes, space travel, drugs)

BD (2E,228)

- Knows that mathematical models can be displayed on a computer and then manipulated to see what happens when the model is treated in different ways

BD (2E,228)

- Knows that because a model is never exactly the same as what it is modeling, different models can represent the same thing

BD (2E,228)

- Knows that the usefulness of a model may be limited if it is too simple or needlessly complicated

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BD (2E,228)

- Knows that what kind of a model to use and how complex it should be depends on its purpose, and that making choices about a model is one of the times that intuition and creativity come into play in science, mathematics, and engineering

Level IV

BD (2E,228)

- Knows that the basic idea of mathematical modeling is to find a mathematical relationship that behaves in the same way the objects or processes under investigation do

BD (2E,228;NI,21)

- Knows that sometimes a mathematics model may give insight about how something really works, but sometimes a mathematical model may fit observations very well and yet have no intuitive meaning

BD (2E,228;CI,89)

- Knows that computers have greatly improved the power and use of mathematical models by performing computations that are very long, very complicated, or repeated over and over thousands or millions of times

BD (2E,228)

- Knows that computer power and capacity make it possible to figure out the consequences of applying complex rules or changing the rules in mathematical models

BD (2E,228)

- Knows that the graphic capabilities of computers make them very useful in the design and testing of devices and structures in the place of physical models, and in the simulation of complicated processes

BD (2E,229)

- Knows that the usefulness of a model can be tested by comparing its predictions to actual measurements or observations in the real world

BD (2E,229)

- Knows that if the match between a model's predictions and the actual data is close, the model can be considered to be successful but not necessarily "truer" than other models that also produce a close match

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(2E,229)

33. Knows about patterns of change and constancy

Level I

BD (2E,230)

- Knows that things change in some ways and stay the same in some ways

BD (2E,230)

- Knows that things can change in different kinds of ways, such as in size, heaviness, color, motion and warmth

BD (2E,230)

- Knows that some changes can be detected by taking measurements

BD (2E,230)

- Knows that sometimes making up an experiment helps us to learn more about how something changes

BD (2E,230)

- Knows that some changes are so slow that they are hard to notice, and some are too fast to follow

BD (2E,230)

- Knows that some things are shaped so that they look the same from different directions

Level II

BD (2E,230)

- Knows that things change in steady, repetitive, or irregular ways, or sometimes in more than one way at the same time, and that a table or graph of observations or measurements often is the best way to tell which kinds of change are happening

BD (2E,231;CI,32)

- Knows that a system may stay the same because nothing is happening to it or because the things happening to it exactly counterbalance one another

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BD (2E,231;NI,126)

- Knows that physical and biological systems tend to change until they become stable and then remain that way unless their surroundings change

Level III

BD (2E,231)

- Knows that many systems contain feedback mechanisms that serve to keep the system within specified limits of variation

BD (2E,231)

- Knows that symbolic equations can be used to summarize how the quantity of something changes over time or in response to other changes

BD (2E,231)

- Knows that symmetry can determine properties of many, though not all, objects, from molecules and crystals to organisms and designed structures and that the symmetry of an object can be determined by seeing if it looks the same when rotated about an axis, reflected, shifted, or stretched

BD (2E,231;CI,31)

- Knows that things that change in a repetitive way, such as the seasons or body temperature, can be described by how long the change cycles last (or by how many cycles occur in a given amount of time, which amounts to the same thing), what the peak value is, and when in the cycle the peak occurs: some phenomena, such as ice ages, take tens of thousands of years to complete one cycle, whereas others, such as light waves, have billions of cycles per second

Level IV

BD (2E,232;TI,70)

- Knows that a system in equilibrium may return to the same state of equilibrium if the disturbances it experiences are small; but large disturbances may cause it to settle into some other state of equilibrium

BD (2E,232)

- Knows that along with the theory of atoms, the concept of the conservation of matter led to revolutionary advances in chemical science

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BD (2E,232;NE,110)

- Knows that the concept of conservation of energy -- which holds that the total amount of energy in any closed system remains constant regardless of what goes on in the system -- is at the heart of advances in fields as diverse as the study of nuclear particles to the study of the origin of the universe

BD (2E,232)

- Knows that graphs and equations are generally equivalent ways for depicting change and constance

BD (2E,232)

- Knows that in many physical, biological, and social systems, changes in one direction tend to provoke changes in the opposite direction, leading to repetitive cycles of behavior

BD (2E,232)

- Knows that the main idea of evolutionary change is that the present arises from the materials and forms of the past, more or less gradually, and in ways that can be explained

BD (2E,232)

- Knows that most systems above the molecular level involve so many parts and forces and are so sensitive to tiny differences in conditions that their precise behavior is unpredictable, even if all the rules for change are known

BD (2E,232)

- Knows that predictable or not, the precise future of a system is not completely determined by its present state and circumstances, but also depends on the fundamentally uncertain outcomes of events on the atomic scale

(2E,233)

34. Understands that the way things work often changes with scale

Level I

BD (2E,234)

- Knows that many things in nature and things people build come in sizes, temperatures, and speeds that are very different -- from very small to very large, very hot to very cold, very fast to very slow, and so on

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BD (2E,234)

- Knows that how big things look depends on how far away they are

Level II

BD (2E,234)

- Knows that finding out what the biggest and the smallest possible values of something are is as important as knowing what the average value is

BD (2E,234)

- Knows that whenever possible, it is better to rely on measurements, or calculations based on measurements, than to depend on perception alone to estimate the magnitude of things

Level III

BD (2E,235)

- Knows that something that is about ten times smaller or larger, closer or farther, etc., than something else is different by an order of magnitude

BD (2E,235)

- Knows that representing large numbers in terms of orders of magnitude makes it easier to think about them and to compare things that are greatly different in magnitude

BD (2E,235)

- Knows that properties of systems that depend on volume, such as capacity and weight, change out of proportion to properties that depend on area, such as strength or surface processes

BD (2E,235)

- Knows that as the complexity of any system increases, gaining an understanding of it depends increasingly on summaries, such as averages and ranges, and on descriptions of typical examples of that system

Level IV

BD (2E,236)

- Knows that because different properties are not affected to the same degree by changes in scale, large changes in scale typically change the way that things work; an important

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example is that as a system grows in size, communication with its surface becomes progressively more delayed

BD (2E,236)

- Knows that as the number of parts of a system grows in size, the number of possible internal interactions increases roughly with the square of the number of parts

BD (2E,236)

- Knows that properties that the individual parts of the system do not have often emerge in a complex system, and these emerging properties can be used without having to understand all of the parts of the system

BD (2E,236)

- Knows that complex systems may show characteristics that are not predictable from the interaction between their components, even when those interactions are well understood

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8. Mathematics

The following process was used to identify standards within the field of mathematics.

Identification of National Reports

Two basic reports were identified as the primary documents representing the current thinking on standards within mathematics: Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989) and the Mathematics Assessment Framework (NAEP, 1992). As mentioned in Section 2 of this report, the NCTM document was a major contributor to the national awareness of the benefits of identifying standards in content domains. To prepare for the 1994 NAEP mathematics assessment, the National Assessment Governing Board awarded a contract in the fall of 1991 to the College Board to develop item specifications for the 1994 assessments. Explicit in this project was an alignment with the NCTM standards, since they were believed to reflect the most current thinking on what students should know and be able to do in mathematics. The resulting report entitled Mathematics Assessment Framework provided specific recommendations regarding the content that should be included in the 1994 NAEP assessment, the levels at which students should be assessed regarding specific content, and the proportion of items that should be devoted to specific content at specific levels.

Selection of Reference Document

Because of its wide recognition, the NCTM document was selected as the reference report. Additionally, the report had characteristics amenable to the standards/benchmarks model used in this study. Specifically, the report explicitly identifies standards at three developmental levels — grades k-4, 5-8, 9-12. The later two levels corresponded well with levels 3 and 4 used in this study. However, the elements identified in the k-4 level of the NCTM document were necessarily reclassified into level 1 (primary) or level 2 (upper elementary) for the purposes of this study.

Identification of Standards and Benchmarks and Integration of Information From Other Documents

Close examination of the NCTM levels indicated that in some cases there appeared to be little designed relationship between the content in one developmental level and that in the next. Not infrequently new types of knowledge and skill were introduced at a superordinate level that seemed to have no developmental relationship to the knowledge and skill identified in the subordinate level. Consequently, many elements within the various NCTM standards and levels were reclassified as more appropriately fitting within another standard. This reclassification process was highly influenced by the NAEP document. Were the NCTM document identifies thirteen standards at levels 1 and 2 and fourteen standards at level 3, the NAEP document identifies five general categories articulated at three levels roughly equivalent to the three NCTM levels. Our reclassification tended to collapse some of the NCTM standards such that the final set of eight standards (see below) resembled the NAEP classification as much as it did the NCTM classification. In effect, our reclassification tended to erode the original structure of the NCTM document.

Another factor contributing to the erosion of the structure of the NCTM organizational structure was its inclusion of explicit standards regarding mathematics as reasoning and mathematics as communication. For reasons discussed in Section 3 of this report, many of the elements identified within the NCTM standard on mathematics as reasoning were judged to more appropriately classified under one of the standards within our thinking and reasoning category, and many of the elements within the NCTM standard on mathematics as communication were judged to be more appropriately classified under one of the standard within our communication and information processing category.

Finally a number of the elements in the NCTM document were identified either as "expert" in nature or curriculum standards, as opposed to content standards, and were not included in the analysis.

(ME,23)

1. Effectively uses a variety of strategies within the problem solving process

Level I

BP (MI,23;PI,27)

- Brainstorms possible things to do

BP (MI,23,26;PI,27)

- Draws pictures to represent problems

BP (ME,26,29)

- Represents problem situations using physical objects

BP (MI,23,26)

- Clarifies problems using discussions with teacher or knowledgeable others

Level II

BP (MI,75;PI,27)

- Uses guess and check to solve problems

BP (MI,23;PI,27)

- Clearly states problems in his or her own words

BP (MI,36,75;PI,27)

- Checks the reasonableness of results through estimation

BC (MI,23,32;PI,41)

- Articulates similarities and differences between basic problem solving strategies

BP (ME,36;PE,27)

- Makes attempts to verify solutions or results in situations where it is warranted

BP (MI,75,78)

- Constructs physical representations for complex problems

BP (MI,75,78)

- Uses pictographs and graphic representations to model problems

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- Clarifies problems using discussions with peers — BP (MI,75,78)

Level III

- Identifies a similar problem type to solve a problem — BP (MI,75;PI,27)
- Breaks larger problems into smaller problems — BP (MI,75;PI,27)
- Works backwards from the solution to solve a problem — BP (MI,75;PI,27)
- Uses substitution within given formulas and expressions — BP (MI,75;PI,27)
- Represents problems using geometric models — BP (ME,112)
- Identifies similarities and differences between a wide variety of problem types and problem solving strategies — BC (MI,75,84;PI,41)
- Effectively verifies solutions or results in situations where it is warranted — BP (MI,94;PE,27)

Level IV

- Designs and carries out statistical experiments — BP (MI,137;PI,27)
- Uses linear programming to solve problems — BP (ME,176;PI,27,43)
- Classifies problem solving strategies or problem types by underlying general characteristics — BC (MI,137,146;PI,41)
- Represents problems using algebraic functions and graphs of those functions — BP (MI,150,176)

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BP (ME,176;PI,43)

- Uses difference equations to solve problems

(MI,38;PI,25)

2. Understands and applies basic and advanced properties of numbers

Level I

BD (MI,38;PI,25)

- Has a general understanding of the concept of number

BC (ME,38;PE,25)

- Uses counting to exemplify numbers

BC (MI,38;PE,25)

- Uses number lines to describe numbers

BC (ME,91;PE,25)

- Orders small sets of numbers

Level II

BD (ME,57,87;PE,25,26)

- Understands the relationship of decimals to whole numbers

BD (ME,57,87;PE,26)

- Understands the relationship of fractions to decimals and whole numbers

BD (MI,38;PE,27)

- Understands the basic difference between odd versus even numbers

BD (ME,57;PI,26)

- Understands the basic characteristics of mixed numbers

BD (ME,38;PE,25)

- Understands the role and function of place value

BC (MI,38;PE,25)

- Models numbers using number lines

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- Renames numbers — BC (M1,38;PE,25)

Level III

- Understands the similarities and differences between rational numbers and irrational numbers — BD (ME,87;PE,27)
- Understands the role of integers in the number system — BD (ME,87;PI,25)
- Understands the relationship of prime numbers to other numbers — BD (ME,91;PE,28)
- Understands the similarities and differences between fractions, ratios, proportions and percents — BD (ME,87;PE,27)
- Solves problems involving fractions — BP (ME,57,87;PI,26)
- Solves problems involving ratios — BP (ME,87;PE,27)
- Solves problems involving proportions — BP (ME,94;PE,27)
- Solves problems involving percents — BP (ME,87;PE,27)
- Expresses numbers using scientific notation — BP (ME,87;PI,25)
- Models numbers using two-dimensional regions — BC (ME,87;PE,25)

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Level IV

- Understands characteristics of the real number system and its subsystems — BD (MI,184;PI,42)
- Understands the relationship between roots and exponents — BD (MI,87;PI,42)
- Solves problems involving roots and exponents — BP (MI,87;PI,42)
- Models numbers using three-dimensional regions — BC (ME,87;PE,25)
- Compares and contrasts elements of the real number system — BC (ME,184)

(ME,94;PI,26)

3. Uses basic and advanced procedures while performing the process of computation

Level I

- Adds, subtracts, multiplies, divides whole numbers with accuracy — BP (ME,94;PE,26)

Level II

- Adds, subtracts, multiplies, divides decimals with accuracy — BP (ME,94;PI,26)
- Rounds whole numbers — BP (MI,36;PE,26)
- Mentally adds and subtracts basic combinations of whole numbers with reasonable accuracy — BP (ME,44;PI,26)
- Determines the effects of addition, subtraction, multiplication and division on size and order of numbers — BP (MI,44;PE,26)

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Level III

BP (MI,94;PI,26)

- Adds, subtracts, multiplies, divides mixed numbers and fractions

BP (MI,94;PE,26)

- Rounds decimals and fractions

BP (MI,94;PI,26)

- Mentally multiplies and divides basic combinations of whole numbers with reasonable accuracy

BP (ME,94;PE,26)

- Uses basic estimation techniques (i.e., overestimate, underestimate, range of estimations)

BP (ME,91;PE,26)

- Uses order operations effectively

BP (ME,94;PE,26)

- Selects appropriate computational techniques in problem solving situations (i.e., paper/pencil/mental/calculator/computer)

BD (ME,91;PE,27)

- Understands the similarities and differences between multiples and factors

Level IV

BP (MI,102;PE,42)

- Adds and subtracts algebraic expressions

BP (MI,94;PE,27)

- Analyzes rounding errors via calculator or computer

(ME,51;PE,29)

4. Understands and applies basic and advanced methods of measurement

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Level I

BD (ME,51;PE,29)

- Understands the relationships between length, width and height

BD (ME,51;PE,29)

- Understands the basic characteristics of weight and how it is measured

BD (ME,51;PI,29)

- Has a basic understanding of the concept of time and how it is measured

BD (ME,51;PI,29)

- Has a basic understanding of the concept of temperature and how it is measured

Level II

BD (ME,51;PE,29,30)

- Understands the basic characteristics of area and how it is measured

BD (ME,51;PE,29,30)

- Understands the basic features of mass

BP (MI,51;PE,29)

- Makes effective use of ruler, thermometer and scale for making measurements

Level III

BD (ME,116,;PE,31)

- Has a basic understanding of the concept of rate and how it is measured

BD (ME,116;PE,30)

- Understands the basic characteristics of perimeter and how it is measured

BD (MI,116;PE,30)

- Understands the characteristics of different types of surface area and how they are measured

BP (MI,116;PE,29)

- Makes effective use of meter stick for making measurements

BP (MI,116;PE,30)

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- Converts from one measurement system to another

BP (MI,116;PE,31)

- Determines significant digits in measurement

BP (ME,116;PE,30)

- Determines the level of accuracy needed in measurement situations

BP (MI,116;PI,31)

- Determines appropriate forms of measurement in a variety of situations

Level IV

BD (ME,51,116;PE,29)

- Understands the basic characteristics of the concept of capacity and how it is measured

BD (MI,116;PI,29)

- Has a basic understanding of the concept of velocity and how it is measured

BD (MI,116;PI,29)

- Has a basic understanding of the concept of acceleration and how it is measured

BP (MI,116;PE,30)

- Determines precision and accuracy of measurements

BP (MI,116;PE,31)

- Analyzes absolute and relative errors in measurement

(ME,48;PE,32)

5. Understands and applies basic and advanced concepts of geometry

Level I

BD (MI,48;PI,32)

- Understands the similarities and differences between circles, squares and triangles

BD (MI,48;PE,34)

- Understands the meaning of the concepts inside/outside/between

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Level II

- Understands the basic characteristics of the concept of three dimensions — BD (MI,48;PI,33)
- Understands the basic features of angles — BD (ME,51,116;PI,34)
- Understands the similarities and differences between a trapezoid, rhombus and quadrilateral — BD (MI,48,112;PI,32)
- Analyzes the effects of combining, subdividing and changing shapes — BC (ME,48;PE,33)

Level III

- Understands the basic characteristics of the concept of symmetry — BD (MI,112;PI,33)
- Understands the relationship between distance and midpoint — BD (MI,112;PE,34)
- Understands the basic characteristics of slope — BD (MI,112;PE,34)
- Understands the similarities and differences between pyramids and prisms — BD (MI,112;PE,30)
- Performs algebraic translations/rotations/reflections of geometric shapes — BP (ME,161;PE,33)
- Analyzes effects of flips, turns, slides in geometric shapes — BC (MI,161;PE,33)
- Analyzes the intersection of two-dimensional figures — BC (MI,161;PI,33)
- Visualizes geometric figures in various rotations — BP (ME,112)

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Level IV

- Understands the basic features of vectors — BD (ME,161;PE,34)
- Understands the relationship between parallelism and perpendicularity — BD (MI,161;PE,34)
- Understands the characteristics and uses of Pythagorean relationships — BD (MI,161;PI,34)
- Performs synthetic translations/rotations/reflections of basic shapes — BP (MI,157;PE,33)
- Solves problems involving vectors — BP (ME,161;PE,35)
- Solves problems involving the Pythagorean relationship — BP (MI,161;PE,34)
- Analyzes the intersection of three-dimensional figures — BC (ME,157;PI,33)
- Classifies figures based on congruence — BC (ME,157)

(MI,54,171;PE,36)

6. Understands and applies basic and advanced concepts of data analysis and distributions

Level II

- Has a basic understanding of the concept of data — BD (MI,54,;PI,36)
- Collects and organizes simple data sets to answer questions — BP (ME,54,105;PE,37)

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Level III

BD (ME,171;PE,37)

- Understands the basic features of a distribution

BD (MI,171;PE,37)

- Understands basic characteristics of measures of central tendency (mean, median, mode)

BD (ME,105;PE,37)

- Understands similarities and differences between tables, bar graphs and circle graphs

Level IV

BD (ME,176;PE,43)

- Understands the basic features of data sets (matrices)

BD (ME,171;PE,37)

- Understands the basic features of the standard normal distribution

BD (MI,171;PE,37)

- Understands the basic measures of dispersion (i.e., standard deviation, variance)

BD (MI,167;PE,37)

- Understands the basic features of outliers and procedures to deal with them

BP (MI,167;PE,37)

- Represents data using stem and leaf plots and scatter plots

BP (ME,176;PE,43)

- Solves problems involving data matrices

(ME,167,171;PE,36)

7. Understands and applies basic and advanced concepts of probability and statistics

Level II

BD (ME,54;PI,36)

- Has a basic understanding of the concept of chance

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Level III

BD (ME,108;PE,37;2E,250)

- Understands the basic features of a sample and sampling error

BP (ME,171;PE,38)

- Estimates probability using simulation

BP (PE,38)

- Identifies common errors in the presentation of statistics

Level IV

BD (ME,171;PE,37)

- Has a basic understanding of the concept of random variables

BD (MI,171;PI,39)

- Understands the similarities and differences between joint and conditional probability

BD (MI,171;PI,39)

- Has a basic understanding of the concept of independence

BD (MI,167;PI,37)

- Understands the basic features of a statistic

BP (MI,171;PE,38)

- Determines probability through trees, formulas, permutations and counting

BP (MI,171;PE,39)

- Solves problems involving conditional probability and joint probability

BC (MI,108;PI,39)

- Compares experimental results with mathematical expectations of probabilities

(ME,102;PE,40)

8. Understands and applies basic and advanced properties of functions and algebra.

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Level I

- Identifies basic number patterns — BP (ME,29;PE,27)

Level II

- Has a basic understanding of the concept of variable — BD (ME,102;PE,41)
- Interpolates simple patterns of numbers — BP (ME,29;PE,41)
- Extrapolates simple patterns of numbers — BP (ME,29;PE,41)

Level III

- Understands the basic features of mathematical expressions — BD (ME,102;PE,41)
- Understands the basic features of coordinates — BD (MI,102;PI,41)
- Has a basic understanding of the concept of equation — BD (ME,102;PE,41)
- Understands characteristics and uses of the concept of rectangular coordinates — BD (MI,102;PE,41)
- Solves problems involving rectangular coordinates — BP (MI,102;PI,41)
- Solves problems involving formulas with one variable — BP (MI,102;PI,41)

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Level IV

- Has a basic understanding of the concept of a function — BD (MI,154;PI,41)
- Understands characteristics and uses of basic trigonometric functions — BD (ME,163;PE,44)
- Has a basic understanding of the concept of inequalities — BD (ME,150;PE,41)
- Has a basic understanding of parameters and their effects on curve shape — BD (ME,154;PE,43)
- Understands that a correlation measures the linear relationship between two sets of data — BD (ME,167;PE,37)
- Has a basic understanding of polynomial equations — BD (ME,180;PE,43)
- Understands basic trigonometry functions — BD (ME,163;PE,44)
- Solves problems involving polar coordinates — BP (ME,163;PE,41)
- Determines the maximum and minimum points on a graph — BP (ME,180;PI,41)
- Fits a line to a set of points — BP (MI,167;PE,38)
- Fits a curve to a set of points — BP (ME,167;PE,38)

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9. History

The following process was used to identify standards within the field of history:

Identification of National Reports
Five reports were identified as important documents representing current thinking on essential knowledge in history: those drafts with sample standards available to us from the National History Standards Project (1993, March; 1992, November); Lessons From History: Essential Understandings and Historical Perspectives Students Should Acquire from the National Center for History in the Schools (NCHS); the Framework for the 1994 NAEP U.S. History Assessment; Building a History Curriculum: Guidelines for Teaching History in the Schools (Bradley, 1988), and "History—Social Science" from Model Curriculum Standards (California Dept. of Ed., 1985).

Selection of the Reference Document
The National Center for History in the Schools' (NCHS) Lessons From History: Essential Understandings and Historical Perspectives Students Should Acquire was selected as the reference document. The NCHS document was selected for several reasons. First, drafts from the History Standards Project were primarily overview and policy documents, furnished with only sample standards; second, the selected reference document was complete, and authored by the administrators of the standards project; and third, a comparison of the sample standards with the reference document indicated how the NCHS Lessons document was being used, and thus made it possible to extrapolate the content standards with some level of confidence. [3]

Identification of Standards and Benchmarks
Sample content standards provided us with an understanding of the level of generality and the type of category description that will likely characterize future standards. The level of detail in the sample standards appeared appropriate for our model of standards; that is, they described a category at a broad enough level to allow for declarative benchmarks. Once we determined how the equivalent level of information appeared in the reference document, Lessons From History, we were able to extrapolate the content standards. While other factors in the standard-setting process could change the emphasis of any given standard, we believe that we have grounded the standards as well as possible with the information available. In addition to standards in U.S. and World History, one standard, "Understands the historical perspective," was developed from concepts stressed in the Bradley report, as well as in Lessons From History.

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[3] An October, 1993, revision of the history standards draft has only recently become available to us; a quick analysis suggests a shift in direction, both in terms of design and the use of source material. A thorough treatment awaits the next update of this paper. We believe, however, that much of the history standards work in this section will be compatible with the final standards project document.

To develop benchmark information was a little more problematic. Rather than benchmark statements, the sample history standards document provided "performance standards." However, each sample content standard had several of these performance standards, and each performance standard was comprised of a focusing idea and several individual tasks. To illustrate, one sample standard was "Understanding of the causes and character of the American Revolution, the ideas and interests involved in forging the revolutionary movement and the reasons for the American victory." This standard had three performance standards, one of which was:

> *To demonstrate understanding of the causes of the American Revolution, students will be able to:*
>
> - Identify the immediate consequences of the Seven Years War and explain the overhaul of English imperial policy.
> - Chart the course of colonial resistance to imperial policy.
> - Analyze the connection between the political ideas to the economic interests of such groups as northern merchants, southern tobacco and rice planters, yeoman farmers, and urban artisans.
> - Analyze the causes of the outbreak of armed conflict at Lexington and Concord.

Two additional "performance standards," which also included three of four bulleted items of the type above, were:

> *To demonstrate understanding of the principles articulated in the Declaration of Independence, students will be able to...*

and

> *To demonstrate understanding of the revolutionary generation's dilemma regarding slavery, students will be able to...*

The tasks listed under each of these headings, just as in the first heading, dealt with particular ideas that were important to understanding the "stem" idea. This collection of information allowed us to construct benchmarks by identifying how similar information was treated in the reference document, Lessons From History. Generally, such information was equivalent to paragraph summaries, items identified as "Essential Understandings" or, commonly, statements introduced by such phrases as "The student should know..." or "Students should understand that...".

Benchmark information will be found listed at one level, but in practice will be used at levels III or IV (middle and secondary school). In one sense, the "stuff" of history — the defining facts, events and episodes — is not amenable to presentation by developmental levels; aside from the advantages of introducing information in a chronological sequence, we have not discovered other arguments or research on how this kind of material might be benchmarked. As noted in Lessons From History, however, "Historical knowledge must go beyond the factual knowledge implicit in these lists — *important though that knowledge is* — to the explanations of the causes and

consequences of these events and the interpretations which can be drawn concerning their enduring significance" [emphasis, the authors']. In keeping with this, draft material from the National History Standards Project shows how factual knowledge remains the same in a content standard, whether it appears at grades 5-8 or 9-12. What varies is the sophistication of the suggested teaching and learning activities that accompany the content standards, activities that we have elsewhere defined as curriculum standards, as well as the performance standards that accompany the content standards.

Whether given standards are covered in middle or high school appears more a matter for local districts' design considerations. The benchmarks identify what students should know by the time they graduate.

The identification of standard and benchmarks for an "historical perspective" was more straightforward. The case for such a standard was clearly made in the Bradley Commission's Historical Literacy, and the constituent understandings, our "benchmarks," for that standard were clearly identified. Additionally, the authors of Lessons From History returned to these ideas throughout their narrative of U.S. and World History.

Integration of Information From Other Documents

To assist us in verifying the our extrapolation of standards and benchmarks, we consulted NAEP's Framework for the 1994 NAEP U.S. History Assessment, as well as California's Model Curriculum Standards. These documents provided guidance when the choice for emphasis at the benchmark level was not clear.

BD (BE,25; LE,41)

1. Understands the historical perspective

Level IV

BD (BE,25; LE,41)

- Understands that the past affects our private lives and society in general

BP (BE,25; LE,41)

- Knows how to make discerning judgments in public and personal life

BP (BE,25; LE,41)

- Knows how to perceive past events with historical empathy

BD (BE,25; LE,41)

- Understands that cultures are diverse yet share the human condition

BD (BE,25; LE,41)

- Understands that historical events happen in patterned ways

BD (BE,25; LE,41)

- Understands that the consequences of human intentions are influenced by the means of carrying them out

BD (BE,25; LE,41)

- Understands that change and continuity are equally as probable and natural

BP (BE,26; LE,41)

- Knows how to avoid seizing upon particular lessons of history as cures for present ills

BD (BE,26; LE,41)

- Understands the importance of individuals who have influenced history both positively and negatively

BD (BE,26; LE,41)

- Understands that the nonrational, the irrational, and the accidental have affected past events

BD (BE,26; LE,41)

- Understands the relationship between time and place as context for historical events

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(LE,53)

1. Understands major scientific, economic, religious, and political changes in 15th century Europe which led to the great convergence following the arrival of Columbus

Level III or IV

BD (LE,55)

- Understands Europe's emergence from a long period of demographic and economic stagnation, and the intellectual, commercial, and scientific consequences of the Renaissance

BD (LE,55; NI,51)

- Understands the rise of the new monarchies in late 15th century France, Aragon, and Castile; the quickening of seaborne commerce; and the "military revolution" beginning in the 16th century that set off a European arms race and fostered national rivalries in overseas expansion

BD (LE,55)

- Understands the Protestant Reformation, the Catholic-Protestant divisions within Christianity, and how they affected societies on both sides of the Atlantic

(LE,53)

2. Understands the status and complexity of pre-Columbian societies of the Americas and West Africa

Level III or IV

BD (CI,26; LE,55)

- Understands the migration of Asian peoples across the Bering Straits land bridge, their further progress southward and eastward over many millennia, and the development of hundreds of linguistically and culturally distinct societies

BD (LE,55)

- Understands the culture and agricultural practices of Native American societies along the eastern seaboard and in the Southwest where the first North American interactions occurred with the English and Spanish explorers

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BD (LE,56)

- Understands the great ecological variations within Africa, and the cultural diversity that resulted; the populousness of the Kingdoms of West Africa, their agricultural sophistication, the centrality of the family, and their aesthetic sculpture

BD (LE,56)

- Understands the cultural consequences of the early contact between West Africa and the Middle East, and the intellectual center established at Timbuktu

(LE,53; NE,51)

3. Understands the long-term consequences of the meeting of three worlds from the beginnings to 1607

Level III or IV

BD (LE,53)

- Understands the redistribution of the world's population and the catastrophic losses of indigenous populations of the Americas, largely to diseases

BD (LE,53)

- Understands the rise of the Spanish and Portuguese global empires in the rapid Iberian conquests after 1492; and the subsequent rise of the French and English

BD (LE,53)

- Understands the commercial expansion of Europe, the rise of capitalism, and the expansion of systems of forced labor in the Americas

(SE,35)

4. Understands how the European colonies in North America were peopled in the colonial period (1585-1763) and how the colonists interacted with Native Americans and with one another

Level III or IV

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BD (CI,26; LE,60)

- Understands how the English colonies contrasted with the Spanish, Portuguese, and French colonies, particularly in motivation and modes of control

BD (LE,62)

- Understands how relations between colonists and Native Americans varied between that characterized by William Penn's peaceful relations with the Delaware chiefs to such extents as the Pequot massacre in 1637

BD (LE,62; NI,52)

- Understands how European wars drew the English colonists along with their Indian allies into conflict with the Indian allies of Spain and France

BD (LE,66)

- Understands the results of the spectacular population growth during the 18th century (e.g., territorial expansion, a huge growth in agricultural productivity, expanded internal and external commerce)

BD (LE,67)

- Understands the evolution of social organization in the colonies toward more complex ranks and groupings, rural and urban, with increased ethnic diversity

(SE,35)

5. Understands the building blocks of representative government, religious freedom, and ethical values that were established in the colonies and how such ideas and institutions matured as political and religious life changed before 1763

Level III or IV

BD (LE,64-65; NI,52)

- Understands the concepts of English law and government that were transferred to the colonies (e.g., the Massachusetts Body of Liberties, the limit to cruel and unusual punishment, the New England town meeting)

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BD (LE,67)

- Understands the political and constitutional ideas that drew partly on the more radical strains of 17th century English thought (e.g., suspicion of all forms of political power, a high value on colonial political autonomy)

BD (LE,65)

- Understands the major religious systems of colonial America, their key beliefs, and the place of religion in society and in the lives of individuals

BD (LE,64)

- Understands the reformist urges of many of the settlers, especially in New England and in Pennsylvania-New Jersey, which sought to free society from poverty, injustice, and oppression of all kinds

BD (LE,67)

- Understands the growing religious diversity of the colonies, culminating in the first major wave of revivals, the Great Awakening

(SE,35)

6. Understands how the values and institutions of European economic life took root in the colonies and how slavery reshaped both European and African life in the English colonies from 1585 to 1763

Level III or IV

BD (CI,26; LE,64)

- Understands the natural setting that Europeans found and the manner in which they began to shape and exploit the American land (e.g., alteration of the continent's plant and animal life, the concept of land as a commodity)

BD (LE,65)

- Understands how factors such as the abundance of land and the absence of craft guilds nurtured a competitive, entrepreneurial ethos and devotion to private property that grew into cardinal values in American society

BD (LE,65)

- Understands how heavily the early colonial economy relied on white indentured servitude; how this harsh form of bound labor helped lead the way to slavery; and how maritime labor, the labor of artisans, and agricultural labor differed

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BD (LE,68)

- Understands the legal and political apparatus that supported the rise of racial slavery

BD (LE,68)

- Understands the gradual decline of indentured servitude, beginning in the late 17th century in the southern colonies and after 1750 in the northern colonies; and the rapid rise of racial slavery after 1690 in the South and to a lesser extent in the North

BD (LE,68)

- Understands the evolution of African American religion, family life, and patterns of resistance against slavery

(SE,36)

7. Understands the causes and character of the American Revolution, the ideas and interests involved in forging the revolutionary movement, and the reasons for the American victory

Level III or IV

BD (CI,27; LE,70,72-73; SE,83)

- Understands the seeds of revolt, including the overhaul of English imperial policy after the Treaty of Paris in 1763, the effects of the Seven Years War, such issues as taxation without representation and the traditional rights of English people under common law

BD (CI,27; LE,70; NI,53; SE,86)

- Understands the principles articulated in the Declaration of Independence and its arguments for severing colonial ties with England

BD (LE,75; NI,53; SE,88)

- Understands the revolutionary generation's dilemma regarding slavery (e.g., the contradiction between the ideals expressed in the Declaration of Independence and the realities of chattel slavery, the revolutionary goals of enslaved and free African Americans)

BD (LE,70,74-75; SE,89)

- Understands the major stages of the Revolutionary War and the reasons for the American victory (e.g.; the difficulties of the Continental Congress in financing and prosecuting the

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war; the role of George Washington as commander in chief; and the roles of American Indian and African American leaders)

(SE,36)

8. Understands how the American Revolution changed or maintained social and economic relationships among the nation's many groups and regions, and how these relationships changed from 1754-1815

Level III or IV

BD (LE,74-75; SE,91-92)

- Understands the ways in which the Revolution affected women's roles and rights (e.g., the arguments of Abigail Adams, Judith Sargent Murray, and Mary Wollstonecraft)

BD (LE,74-76; SE,93)

- Understands the revolutionary goals of different social groups (e.g., northern and southern property owners, urban artisans, Native Americans) and the Revolution's transformation of social, political, and economic relationships among them

BD (LE,75; SE,75)

- Understands the development of free black communities in the North in the late 18th century (e.g., the free black community of Philadelphia led by Richard Allen, founder of the first independent black denomination in America, the African Methodist Episcopal church)

BD (LE,74,76; SE,95)

- Understands the economic problems of the Revolution, including the proper role of government in the economy, management of the revolutionary war debt, and the advisability of paper money and banks

BD (LE,76,83; NI,53; SE,97)

- Understands how the new nation promoted the development of the American economy after the Revolution (e.g., Alexander Hamilton's financial program, the Land Ordinance of 1785 and the Northwest Ordinance of 1787)

(SE,36)

9. Understands the institutions and practices of government created during the Revolution and how they were revised between 1787 and 1815 to create the foundations of the modern American political system

Level III or IV

BD (LE,73,80; SE,99)

- Understands the Articles of Confederation, the powers it allowed the Continental Congress and the states, and how its weaknesses resulted in a call for the Philadelphia Constitutional Convention

BD (CI,27; LE,74,78; SE,101)

- Understands the significance of rising concern over state governments, and the political theory of republicanism to the Constitutional Convention

BD (LE,78)

- Understands the fundamental ideas and specific provisions of the Constitution

BD (LE,82; NI,53; SE,103)

- Understands the nature of the Constitutional Convention (e.g., the principle participants, the Virginia Plan, the New Jersey Plan, concessions made to the southern states on the issue of slavery)

BD (LE,82; SE,104)

- Understands the ratification debates in the states (e.g., Antifederalist fears of aristocratic government, arguments for preserving the power of democratically inclined state legislatures)

BD (CI,27; LE,83-84; SE,106)

- Understands the Bill of Rights and the threats to those rights that emerged in the 1790's (e.g., the Alien and Sedition Acts of 1798)

BD (CI,27; LE,78,83,84; SE,108)

- Understands the development of the first American party system (e.g., its legitimation in 1800, Federalist and Democratic-Republican opposition), and the foundations of political alliances

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BD (LE,84; SE,109)

- Understands the emerging role of the Supreme Court in the early nation and the origins of judicial review, including the Republican attack on the judiciary, Marbury v. Madison, and the decisions of the Marshall Court

(SE,36)

10. Understands how American external relations changed during the Revolution and in the era of the early republic (1754-1815)

Level III or IV

BD (LE,72,74; SE,111)

- Understands how American relations with European powers affected the character and outcome of the American Revolution (e.g., French and Dutch aid)

BD (LE,90,100-101; SE,113)

- Understands the relations between the new American nation and Native Americans after the Revolution (e.g., the series of military campaigns and treaties that transferred Indian title of much of the Old Northwest territory to the new nation)

BD (CI,27; LE,84; NI,53; SE,115)

- Understands the causes, character, and effects of the War of 1812

(SE,37)

11. Understands U.S. territorial expansion between 1800 and 1861, and how this involved changing relations with external powers and Native Americans

Level III or IV

BD (CI,27,28; LE,98; NI,54)

- Understands territorial expansion through international diplomacy (e.g., the Louisiana Territory) and through war, justified by the doctrine of Manifest Destiny

BD (LE,98)

- Understands the major population shifts to the Far West over the Oregon and California Overland Trails

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BD (LE,98)

- Understands the frontier as a zone of cultural interaction between Native Americans already in the region and new arrivals moving westward from the eastern U.S., northward from Mexico, and eastward from Asia

BD (LE,93,98)

- Understands 19th century federal policy toward Native Americans, including the crisis of 1829 following Jackson's election, and removal of the six southern nations to the western territories

(SE,37)

12. Understands how the first American industrial revolution and the rapid expansion of slavery occurred in the first half of the 19th century, how they changed the lives of Americans, and how they led toward regional identities and tensions

Level III or IV

BD (LE,87)

- Understands the entrepreneurial innovations and technological developments that industrialized the North and led to the rapid expansion of water and rail transportation linking the nation's regions

BD (LE,85,110; NI,54)

- Understands the rapid spread of slavery throughout the piedmont and trans-Appalachian South, especially after Eli Whitney's technological breakthrough; and the resulting sectional differences over slavery

BD (LE,87)

- Understands important demographic changes during this period, including advances in the American standard of living, the growth of cities, the influx of Irish and German immigrants, and migrations of free blacks and escaping slaves from the South to the North

(SE,37)

13. Understands the way in which political democracy was extended, restricted, or reorganized between 1801 and 1861, and why the party system began to collapse at mid-century

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Level III or IV

BD (LE,92)

- Understands increasing popular participation in both state and national politics; the changing styles of political campaigning; and the continued exclusion from the political process of women, and in many states, the new exclusion of free blacks

BD (LE,93)

- Understands the development of the second American party system that emerged in the mid-1830's and how party identification played an increasingly large part in the lives of American men

BD (CI,27; LE,93; NI,54)

- Understands the presidency of Andrew Jackson, including his tariff policy, his war against the Second Bank of the United States, and his reputation as "champion of the common man"

BD (LE,93)

- Understands the great Congressional debates of the period, which dealt with the broad issues of regionalism, protectionism, and federal activism in promoting economic development

(SE,37)

14. Understands the sources and character of religious, social, and political reform impulses, and what the reformers accomplished or failed to accomplish between 1801 and 1861

Level III or IV

BD (LE,94)

- Understands the religious roots of antebellum reform (e.g., the Second Great Awakening, utopian communities)

BD (CI,27; LE,89)

- Understands the several strains of reform (e.g., public education, abolitionism) and the role of individual leaders (e.g., William Lloyd Garrison, Dorothea Dix, Arthur and Lewis Tappan)

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BD (LE,89)

- Understands the legacies and connections to later reform periods of the Progressive and New Deal eras

(SE,38)

15. Understands the causes of the Civil War

Level III or IV

BD (LE,106; NI,55)

- Understands the defenders and opponents of the slave system; the work and life of enslaved families and their resistance to slavery; and the status and experience of free black Americans in the North, South, and West

BD (CI,27; LE,109,111,112)

- Understands the attempts at compromise and why they failed (e.g.; the Compromise of 1850; fundamental cultural, economic, and political differences between the North and South)

BD (LE,109)

- Understands the coalescing of anti-slavery interests in the Republican Party, and how Lincoln's election led to secession and war

(SE,38)

16. Understands the course and character of the Civil War and its effects on the American people

Level III or IV

BD (LE,109)

- Understands the importance of the leadership of Lincoln, Davis, Grant, and Lee to the course of the Civil War

BD (LE,109,113)

- Understands the strengths and weaknesses of both sides, and the war's major stages and campaigns from Fort Sumter to Appomattox

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BD (LE,109)

- Understands the life of the common soldier

BD (LE,114)

- Understands life on the home front and the many roles of women during the war

BD (CI,28; LE,106)

- Understands the character, words, and works of Abraham Lincoln as President and war leader

(SE,38)

17. Understands the various plans for reuniting and reconstructing the nation and the successes and failures that had occurred by 1877

Level III or IV

BD (CI,28; LE,106)

- Understands the circumstances and limits of the Emancipation Proclamation; and the significance in the short and the long run of the Thirteenth, Fourteenth, and Fifteenth Amendments

BD (LE,114-115)

- Understands how presidential and congressional Reconstruction came into existence, the congressional rejection of Lincoln-Johnson Reconstruction, and the 14th and 15th amendments

BD (CI,28; LE,115)

- Understands the economic and social aspects of Reconstruction (e.g., the impoverishment of the south, the reemergence of southern white supremacy, the efforts of the Freedmen's Bureau, the inadequacy of economic aid to freed slaves)

BD (LE,109,115)

- Understands the overall effects and legacy of the Civil War and Reconstruction (e.g., the expansion of the power of the federal government, the shift of economic power toward northern industrialists and away from southern planters)

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(CI,28; SE,39)

18. Understands the rise of big business, heavy industry, and mechanized farming and how the resulting economic transformation affected American life between 1870 and 1900

Level III or IV

BD (LE,122)

- Understands the tremendous increase in economic productivity combined with a momentous concentration of the nation's productive capacity in a much smaller number of businesses, and how Social Darwinism was used to justify the new industrial order

BD (LE,124)

- Understands the rise of the American city, including the advent of mechanized mass transportation, the development of modern urban services such as fire and police protection, and new modes of leisure (e.g., spectator sports, motion pictures, museums)

BD (LE,125)

- Understands the plight of farmers as they faced an industrializing country where transportation and storage facilities were controlled by powerful corporations

(SE,39)

19. Understands how massive immigration and internal migration after 1870 led to new social patterns, conflicts, and ideas of national unity amidst growing cultural diversity between 1870 and 1900

Level III or IV

BD (LE,123; NI,56)

- Understands the motives, expectations, and experiences of different immigrant groups as well as the nativist hostility to newcomers

BD (LE,123)

- Understands the role of public schools in extending literacy and in forging an American nation during a period of rapidly increasing ethnic and cultural diversity

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BD (CE,28; LE,124)

- Understands the movement of farm families to towns and cities, and the development of suburbs to which the rapidly growing middle class began to migrate

BD (LE,125)

- Understands how the Homestead Act of 1862 fueled the expansion of migration on the Great Plains and the Second Great Removal of the Native Americans

(SE,39)

20. Understands how the rising American labor movement and the political issues of this era reflected social and economic changes produced by industrialization, mechanized farming, immigration, racial division, and the rise of cities between 1870 and 1900

Level III or IV

BD (LE,124)

- Understands the organizational and employment changes that took place as a result of large-scale industrialization (e.g., a gradually shortened workday, new material comforts, low wages in some sectors, high accident rates, unhealthy working conditions)

BD (CI,28; LE,124)

- Understands the role of the labor movement and the intervention of state and federal government against strikes from the late 1870's through the 1890's

BD (LE,125)

- Understands farmers' attempts to organize in the Populist movement and the initiation of the federal government's special protection of farmers

BD (CE,28; LE,126)

- Understands politics in the Gilded Age (e.g., corruption, urban bossism, creation of the Civil Service Commission)

(SE,39)

21. Understands the expansionist foreign policy that emerged after the Civil War

Level III or IV

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BD (LE,135; NI,56)

- Understands the 19th century imperial expansion of the major European nations into Africa and Asia

BD (CI,28; LE,139-140)

- Understands the causes and conduct of the Spanish-American War (e.g., the American investment in Cuban sugar, the unsolved sinking of the American battleship Maine in Havana harbor, Theodore Roosevelt at San Juan Hill, the American attack on the Spanish fleet in the Philippines)

BD (CI,28; LE,135; NI,56)

- Understands U.S. territorial ambition through its annexation of Hawaii and its acquisition of Puerto Rico, Guam, and the Philippines, following the Spanish-American War

BD (LE,139)

- Understands the political, economic, and religious motives of American imperialism (e.g., the need for new markets and raw materials, the race for strategic military bases, the missionary impulse)

(CI,29; LE,127)

22. Understands how the Progressive movement tried to respond to problems arising from rapid industrialization, urbanization, waves of immigration, and business and political corruption of the late 19th century

Level III or IV

BD (LE,128)

- Understands who the Progressives were, their central aims and ideals, the sources of their zeal, and the nature of their limitations

BD (LE,128)

- Understands the Progressives' major rivals and obstacles, their major allies and supporting forces

BD (CI,29; LE,128; NI,56)

- Understands the major accomplishments and setbacks of the Progressives in the states and on the national level, including the roles of Theodore Roosevelt, William Howard Taft, and Woodrow Wilson

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BD (LE,129)

- Understands the weaknesses and evasions of the Progressives on the issues of race and labor in the U.S., and the impact of WWI in halting much of the movement

(LE,136,141)

23. Understands the causes of WWI, its effects on American political, economic, social and cultural life, and the deeper repercussions of the war that would shape the rest of the century for most of the world

Level III or IV

BD (LE,136,141; NI,57)

- Understands the multiple causes of WWI, the events through which it became a world war, and the reasons behind the entry of the United States

BD (LE,141)

- Understands how the war prompted new manufacturing and business techniques, federal intervention in the economy, and the effects of war on women and African Americans who were brought into industrial work to an unprecedented degree

BD (LE,141)

- Understands how the war became the occasion for xenophobia; attacks on free speech and press; vigilantism; and hostilities against foreigners, minorities, and labor unions

BD (LE,142)

- Understands the process of peacemaking, and how American attitudes discouraged American participation in the work of peace-keeping in the 1920's down to WWII

(LE,143)

24. Understands the foundations established during the 1920's for the nation's political economy and culture

Level III or IV

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BD (LE,147)

- Understands the nature of Herbert Hoover's economic policies (e.g., standardization of manufactured goods, the development of trade associations, the regulation of new enterprises such as radios and airlines)

BD (LE,147)

- Understands how the industrial expansion of the 1920's brought significant changes that have since characterized modern American life (e.g., the advent of automobility, the growth of white collar jobs for women, suburbanization, a communications revolution)

BD (LE,144)

- Understands that large parts of the U.S. population were left outside the era of opportunity and advancement (e.g., farmers, Native Americans, Mexican Americans)

(LE,147)

25. Understands important post-WWI problems in the nation's internal and international affairs

Level III or IV

BD (CI,29; LE,149)

- Understands the cultural and political clashes of the 1920's including the Scopes trial and the victory of prohibition

BD (LE,149; NI,57)

- Understands the decade's retreats from democracy (e.g., the suspicions aroused by the Sacco-Vanzetti trial, the imposition of federal immigration quotas)

BD (CI,29; LE,149)

- Understands the causes of renewed racial tensions, and the African American response (e.g, the rise of the NAACP, the Harlem Renaissance)

BD (LE,145)

- Understands America's alternately isolationist and interventionist role in the world including the international policy of nonaggression and arms control, and the U.S. repayment policy on wartime loans to Allies

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(CI,29; LE,152,153)

26. Understands the causes of the Great Depression; its effects on people and society; and the relief, recovery and reform of the New Deal

Level III or IV

BD (LE,154)

- Understands how the economic dislocations of WWI, governmental policies of the 1920's, and the stock market Crash of '29 brought about the Depression

BD (LE,156)

- Understands what it meant for families in the cities and in the country to see their economic livelihoods threatened and disappear

BD (LE,156)

- Understands how Franklin D. Roosevelt's success in restoring people's faith in constitutional government and free enterprise also defeated those who sought a revolutionary end to the system

BD (LE,158)

- Understands that the main thrust of the New Deal was to restore and increase the purchasing power of as many Americans as possible, as well as to restore public confidence in banks and the stock market, to open new markets for consumer goods, and to revive international trade

BD (LE,153)

- Understands the successes, failures, and overall significance of the New Deal to the society and politics of the U.S.

(LE,165)

27. Understands the origins of WWII and the American entry into war

Level III or IV

BD (LE,166)

- Understands the major principles of Nazism and Fascism (e.g., totalitarianism, militarism, racism), and the reasons Germany and Italy turned to them

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BD (LE,166)

- Understands the forces behind the rise in Japan of military expansionism, including Japanese ill-feeling toward the United States, dating back to the Open Door policy, to the annexation of the Philippines, and to the exclusion of Japanese immigrants

BD (LE,166)

- Understands the strident American neutralism of the 1930's, and how it took the Japanese attack on Pearl Harbor to send the U.S. to war

(LE,163)

28. Understands the European and Asian theaters of war, and WWII on the American homefront

Level III or IV

BD (LE,167)

- Understands the period of intense danger (1939-1942), when it looked as if the Axis powers might win; the turnaround in the second period (1943-1944); and the victory in both theaters in the war's third period (1944-1945)

BD (CI,29; LE,167)

- Understands that the war ended the Depression in the U.S., created a "miracle" of American production and nearly full employment, but also greatly distorted the balance and workings of the economy

BD (CI,29; LE,167)

- Understands the important human and social events and changes of these years (e.g., the internment of Japanese Americans, the massive influx of women into previously male job roles, the large shifts in population to war-production centers)

(LE,163)

29. Understands the motivations, terms, and consequences of the major agreements and alliances for peace before and after the end of WWII

Level III or IV

BD (CI,29; LE,168)

- Understands the initiatives for peace and the purposes that inspired them (e.g., the Atlantic Charter, the Bretton Woods Conference, the formation of the United Nations)

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BD (LE,168)

- Understands the wartime meetings of Roosevelt, Stalin, and Churchill at Tehran and Yalta in order to maintain the Anglo-American alliance and to insure international security

BD (LE,168)

- Understands how, in the Potsdam conference between Truman and Stalin, tensions between the Soviet Union and the U.S. had increased to the point that no common ground could be found

(LE,165)

30. Understands the origins and conduct of the Cold War and its domestic effects from 1945 to 1975

Level III or IV

BD (CI,29; LE,168-169)

- Understands that the U.S. launched its containment policies (e.g., the Truman Doctrine, NATO) in response to large Communist parties pressing for power in Western Europe, and how containment was successfully conducted

BD (LE,169)

- Understands how the American anti-Communist strategy of containment in Asia confronted very different circumstances from those of Western Europe

BD (CI,29; LE,170)

- Understands the domestic anti-Communist crusade of the 1950's when McCarthyism threatened to stifle dissent; and such developments as the Soviet acquisition of the atomic bomb, the atomic spy cases, the Chinese Communist Revolution, and the outbreak of the Korean War

(LE,169-170)

31. Understands the postwar prosperity of the Truman and Eisenhower years

Level III or IV

BD (LE,169)

- Understands the effects of the military-industrial complex and semi-wartime economy brought about by the Cold War

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BD (LE,169-170)

- Understands how the U.S. sustained a high level of purchasing power through the 1950's (e.g., demand for consumer goods, the impact of New Deal reforms, the U.S.' near monopoly of world trade)

BD (LE,170)

- Understands the far-reaching effects of the GI Bill, a gigantic widening of access to higher education, and of low-interest home mortgages

(LE,174; NI,58)

32. Understands social changes in American society brought about by the Civil Rights movements, the women's movement, and the Immigration Act of 1965

Level III or IV

BD (CI,30; LE,170,177)

- Understands how African Americans won more federal recognition and protection (e.g., desegregation of the armed forces, Brown v. Board of Education, Civil Rights Act of 1964)

BD (LE,178)

- Understands the alternative means of protest under a new generation of black leaders: from non-violent civil disobedience, to Black Power confrontations, to massive marches on Washington

BD (LE,178)

- Understands the major issues confronted by the women's movement in the 1960's, including economic issues of equal pay and equal job opportunities, reproductive issues, and political rights invoked seeking greater access to public office

BD (LE,178)

- Understands the parallel civil rights movements of Hispanic and Native Americans (e.g., the rise of the United Farm Workers, Native American struggles for restoration of land and water rights)

BD (LE,180-181)

- Understands the rapid growth of America's cultural and religious diversity since the Immigration Act of 1965 (e.g., how foreign policy opened doors to Asian, Cuban, Haitian, Salvadoran, Jamaican, and Russian Jew immigrants; the rise in Eastern beliefs, and in fundamental and evangelical Christianity)

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(LE,176,178)

33. Understands the domestic programs and foreign policy of the Kennedy and Johnson administrations

Level III or IV

BD (LE,176-177)

- Understands attempts to extend New Deal legislation through federal aid to education, medical care for the elderly, renewal of cities through subsidies, housing support, job training, and direct payments to the poor

BD (LE,177)

- Understands reasons for opposition to these programs and how some were accepted by Republicans under Nixon and Ford as well as Democrats under Carter

BD (LE,179)

- Understands Kennedy's extension of the containment policy through "flexible response" and his creation of the Peace Corps, the Alliance for Progress with Latin American governments, and the Agency for International Development

BD (CI,30; LE,179)

- Understands the origins of the Vietnam War and Johnson's escalation of the American commitment to full military intervention in 1964 to stave off the collapse of South Vietnam

(LE,174,181,182)

34. Understands the foreign policy, the "New Federalism," and the Watergate affair of the Nixon administration

Level III or IV

BD (CI,30; LE,174)

- Understands the Nixon/Kissinger policies of multilateral diplomacy, and of rapprochement with China and Russia

BD (LE,182)

- Understands that while Nixon kept many of Johnson's Great Society programs alive, he initiated his "New Federalism" and with it, cut off funds to support such programs as federal job training, urban renewal, and federal support for education

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BD (LE,182)

- Understands that at the center of the Watergate affair were the increasingly autonomous operations of the American presidency, avoiding those congressional restraints and delays inherent in our system of checks and balances

(LE,176)

35. Understands the changing economic relationships in the post-Vietnam years from 1975 to the present

Level III or IV

BD (CI,30; LE,183)

- Understands the severe economic stagnation and runaway inflation of the 1970's and their causes

BD (LE,183)

- Understands the dramatic recovery of the economy by 1983 as a result of Reagan's supply-side economics, but also record federal deficits resulting in part from a massive increase in military spending, and from heavy tax cuts to stimulate the economy and force cuts in domestic spending

BD (CI,30; LE,183)

- Understands the far-reaching changes in the U.S. economy with the increased foreign competition it has faced in the world market

(LE,176)

36. Understands U.S. foreign policy from 1975 to the present

Level III or IV

BD (LE,184)

- Understands how Presidents Carter and Reagan carried on the policy of containment crafted in the Truman administration (e.g., maintaining a strong military establishment, keeping alliances intact)

BD (LE,184)

- Understands Carter's human rights campaign and the Camp David accords; and Reagan's diplomacy with the Soviet Union, "negotiating from strength"

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BD (LE,185)

- Understands how American moves and countermoves in foreign policy, huge defense expenditures, and the communications revolution contributed to the end of the Cold War

(LE,185)

37. Understands major currents of American thought and culture from 1975 to the present

Level III or IV

BD (LE,185)

- Understands the forces contributing to the nation's intellectual and scientific accomplishments such as the success of American universities and the emergence of powerful centers of scientific research and innovation

BD (LE,186)

- Understands the contributions of American arts and letters, including motion pictures, the nation's most distinctive art form

BD (CI,30; LE,186)

- Understands the growing sense of public urgency for global environmental concerns, for the humane uses of technology, and for the protection of human rights at home and abroad

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(BI,31; LE,197)

1. Understands the major phases of human cultural and physical development from the Paleolithic era to the revolution of agriculture

Level III or IV

BD (CI,37; LE,197)

- Understands the major stages in the evolutionary development of human beings from Homo habilis to Homo sapiens

BD (LE,197)

- Understands the development of early culture, including tool-making and use, language, the use of fire, and forms of social organization

BD (CI,37; LE,198)

- Understands the nature and development of hunter-gatherer economies, including the role of gender in society and work

BD (CI,37; LE,197-199)

- Understands the technological developments of the agricultural revolution, its occurrence around the world, and how it led to permanent settlements, specialization of work, and the reliance on trade

(CI,37; LE,199)

2. Understands the nature of the urban revolution of the ancient Middle East to 1200 b.c.

Level III or IV

BD (LE,199-200)

- Understands the stratified social system of Sumer, its theology, its invention of the cuneiform system of writing, and its contribution to early state formation

BD (LE,200)

- Understands Hammurabi's rule of the Babylonian Empire, the growth of foreign trade, systems of taxation and tribute, and the evolution of a more complex social system

BD (BI,29; GI,37; LE,201)

- Understands how the ancient Hebrews evolved politically from tribal organization into a unified kingdom, and the nature and development of the ethical monotheism, Judaism

(CI,37; LE,202)

3. Understands the evolution of Egyptian society, its major accomplishments, and its contributions to other societies to 1200 b.c.

Level III or IV

BD (LE,203)

- Understands the fundamental role played by the unique geography of the Nile valley in shaping Egyptian civilization

BD (LE,203-204)

- Understands the central place of religion in ancient Egyptian culture and the role of the monarchy as the primary integrating factor in Egyptian civilization

BD (LE,205)

- Understands the life of the Egyptian peasantry as well as that of the craftsmen, scribes, soldiers, lesser priests, women, and slaves

BD (LE,205)

- Understands the nature of the hieroglyphic writing system, including that its complexity ensured that literacy would be the possession of a privileged minority, the scribes

BD (LE,205-206)

- Understands the influence of Egyptian civilization on the cultures, particularly the art and architecture, of the Kush (Sudan) and the Greeks

(BI,30; GI,38; LE,207)

4. Understands the evolution of the early civilizations of India, China, and the Americas

Level III or IV

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BD (LE,207)

- Understands the advancements of the Indus Valley civilization, including its intricate drains, uniform weights and measures, and its destruction by Aryan invaders around 1500 b.c.

BD (CI,37; LE,208-209)

- Understands the prehistoric cultures which emerged in an alluvial valley in north-central China, the development of the foundations of the Chinese state, and the impact of the invention of bronze metallurgy

BD (LE,209)

- Understands the achievements of the Olmecs in Central America (ca. 800-400 b.c.) (e.g., the taming of its tropical environment, its creation of an accurate calendar, its religious and artistic aspects) and the Tiwanakans (300 b.c.), including their differentiated social structure and their system of roads

(BI,29; GI,37; LE,211)

5. Understands the development of new ideas, new political and social institutions, and new systems of thought that characterized the classical civilization of Greece.

Level III or IV

BD (LE,215-216)

- Understands how the Greek achievements of its classical age were indebted to earlier advances on the part of Minoan and Mycenean civilizations, and cultural contact with the more advanced civilizations in the Near East and Egypt

BD (LE,216)

- Understands that building on the Phoenician alphabet, the Greeks developed an alphabet which made the learning of reading and writing easier and more accessible to the population

BD (LE,216)

- Understands the creation of the polis, the emergence of democracy, and the invention of citizenship

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BD (LE,216)

- Understands the strength of Greek society and their desire to fight for their freedom in the Persian War

BD (LE,218)

- Understands the contrasting development of Athens and Sparta, the Peloponnesian War, and its effects

BD (LE,218)

- Understands how the Macedonians and their kings, Philip and Alexander, contributed to the end of both the classical era and the independent city states of Greece, and extended Greek culture throughout the Near East

(LE,220)

6. Understands the process and factors that helped to knit disparate peoples into the Roman Empire

Level III or IV

BD (LE,218-219)

- Understands how the overthrow of the Tarquin kings began the Roman Republic and its legendary hatred of tyrants; and how the Tarquin/Etruscan heritage had a continuing influence on Republican culture

BD (LE,219)

- Understands the course of Roman expansion, including the Punic Wars, Hannibal's near-conquest of Rome, internal changes brought about by empire, and how the spread of slavery transformed the Roman economy

BD (LE,219-220)

- Understands the social and constitutional failures that contributed to the fall of the Republic; and the rise of empire and emperors, beginning with the Augustan settlement

BD (CI,37; LE,220)

- Understands the extent of the Roman Empire, the dynamics of expansion and its effects on subject peoples, and how different peoples influenced the cultural style of the empire

BD (LE,220-221)

- Understands the role of various forces in the collapse of the Empire (e.g., economic decline, social change, political institutions, pressure from Goths and Asian nomads)

(BI,27; LE,221)

7. Understands the historical power of belief and religious institutions through the rise and establishment of Christianity

Level III or IV

BD (LE,221)

- Understands how directly the early Christians drew from their Jewish roots, and how the Hebrew Bible was combined with the teachings of Jesus to form the Christian Bible

BD (CI,38; LE,221-222)

- Understands the impact of St. Paul, of Greek learning, and of the early church fathers in the promulgation of Christian doctrines

BD (CI,38; LE,222)

- Understands the way in which Christian culture survived, was disseminated, and its import throughout the Roman world; how this culture treated women, slaves, the family; and the significance of Constantine's conversion to the empire and the church

(CI,37; LE,222)

8. Understands the development of classical civilizations in India and China

Level III or IV

BD (LE,222)

- Understands how the rise of classical civilization in India (following the Aryan invasions) was contemporary with that of China (with the overthrow of the Shang Dynasty and the establishment of the Zhou Dynasty), and of Greece (following the Dorian invasions)

BD (LE,223)

- Understands the major characteristics of the caste system and how it took shape under Aryan rule

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BD (BI,31; LE,223)

- Understands the origins and development of Buddhism, which emerged in the 6th century b.c. as a new form of Hinduism, which itself developed out of Aryan religious beginnings

BD (CI,38; LE,224)

- Understands the nature of India's many competing kingdoms, its first imperial unification by Chandragupta Maurya, and the disappearance of the Mauryan Empire (324-184 b.c.) with the return of civil war and invasion

BD (CI,38; LE,224)

- Understands the accomplishments of the Gupta civilization in India (320-550 a.d.), including the poetry and plays of Kalidasa; how trade in luxury exports reached to Rome, Africa, China, and Southeast Asia; and contributions to mathematics and astronomy

BD (CI,38; LE,225-226)

- Understands the foundations laid by the Zhou, Chi'n, and Han dynasties for China's strong continuity with its ancient past

BD (LE,225,226)

- Understands how the Zhou Dynasty united existing agricultural communities in a mode of feudalism; how the Chi'n Dynasty established a bureaucratic administration that laid the foundations of the Chinese Empire; and how the Han Dynasty made Confucianism part of the state apparatus

BD (LE,225-226)

- Understands the achievements of classical China (e.g., the development of feudalism; mass-produced iron weaponry; the use of silk, gunpowder, and paper)

BD (BI,31; LE,225-226)

- Understands the success and influence of Confucianism and Buddhism in China

(BI,31; GI,38; LE,233-238)

9. Understands the rise and spread of Islam, the clashes between Islam and Christendom, and the impact of Islam on India

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BD (LE,233-234)

- Understands the major events in Mohammed's life; the basic moral principles Islam shares with Judaism and Christianity; and the major characteristics of the Koran, which served as the doctrinal basis of Islam and also laid down rules for governing all society

BD (LE,235)

- Understands the nature of Islamic society, including the importance of trade and commerce and the prestige given the merchant class as a result; the existence of slavery; the position of women; and the flourishing of philosophy, scientific works, the arts, and law

BD (BI,29; LE,236-237)

- Understands Muslim expansionism under the Seljuk Turks which led to the Crusades and the end of the Byzantine Empire

BD (LE,238)

- Understands the changes Muslim conquerors and Mullahs brought to India (e.g., the clashes between Hindu and Muslim social customs and religious beliefs, the introduction of new architectural styles, the development of Urdu, and the increase in Hindu piety)

(LE,238)

10. Understands the development of the two regions of Europe, East and West, that emerged from the ruins of the Roman Empire between 600 and 1500 a.d.

Level III or IV

BD (CI,38; LE,239)

- Understands the Byzantine Empire's powerful Orthodox Christian heritage, rich artistic traditions, and links to Slavic Europe and Russia

BD (LE,239)

- Understands the problems of the Byzantine Empire, including conquest by their Latin "allies" in 1204, to the reconquest of 1260, to the growing pressure from hostile states all around them, to the eventual triumph of the Turks over them in 1453

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BD (BI,29; LE,240)

- Understands the distinctly different periods and cultures of Western Europe such as the Carolingian Empire, the High Middle Ages, and the crises of the 14th century (e.g., wars, peasant rebellions, political strife)

BD (BI,29; GI,38; LE,241)

- Understands the economic, political, and social aspects of the institution of feudalism

BD (LE,241)

- Understands the beginnings of European expansion (e.g., rise in population, land reclamation, revival of trade and towns)

BD (LE,242)

- Understands how the Church dominated the intellectual and cultural life of the West, competed with princes and kings for power, and strove to regulate everyday morality

BD (LE,242)

- Understands gender inequalities of the Middle Ages (e.g., women were barred from the priesthood, from public office, from courts, etc.), and the accomplishments of women during this era

BD (LE,242)

- Understands how war, internal revolt, and religious dissent led to the end of the Middle Ages

(LE,243)

11. Understands the renewed flowering of Chinese civilization during the Middle Empire between 600 and 1500 a.d.

Level III or IV

BD (CI,38; LE,243)

- Understands that the commercial revolution was facilitated by a sophisticated system of river and land transport that helped to unify the country, and had far-reaching implications for the formation of businesses, urbanization, agriculture, and social mobility

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BD (CI,38; LE,243)

- Understands how the growth of great cities in southern China, technological developments, and contacts with the outside world contributed to the development and expansion of a Chinese trading empire

BD (LE,243)

- Understands the increase in centralized government, the creation of a meritocracy, and the development of a civil service examination system which encouraged a revival of interest in classical learning

BD (CI,38; LE,244)

- Understands the 13th century Mongol conquest of China and their establishment of the Yuan dynasty (1260-1368)

(LI,244)

12. Understands the nature of early Japanese society and the importance of interchange with China from around 500 A.D.

Level III or IV

BD (LE,244)

- Understands the first migrations to the Japanese islands and the development of extensive agriculture

BD (CI,38; LE,244)

- Understands how the Chinese gave the Japanese the foundations of their writing system, the beginnings of their literature, art, philosophy, technology, religion and political forms

BD (LE,245)

- Understands the nature of the aristocracy and peasantry of the Heian period (794-1185), and the growing independence of the military class

BD (CI,38; LE,245)

- Understands the rise of the warrior society and the institution of feudalism that developed in medieval Japan

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(LE,246)

13. Understands the rich and varied achievements of African peoples in the pre-colonial era before 1500 a.d.

Level III or IV

BD (LE,246)

- Understands the extent to which Africans adapted to the land and engaged in creative enterprises (e.g., farming, building cities and kingdoms, inventing new technologies)

BD (LE,247)

- Understands the movements and interactions of peoples across the African continent, and the links with Indian, Arabian, and Mediterranean peoples that were influential in shaping local societies

BD (CI,38; LE,247-248)

- Understands the development of intercontinental trade linking West Africa with a trans-Eurasian trading system and the significance of this well organized trade in African gold, ivory, salt, and slaves

BD (CI,38; LE,248-249)

- Understands the rise of wealthy cities and states in different regions of Africa at different times (e.g., the Nok people in West Africa, the Mali Empire, the Almoravid and Almohad empires)

(CI,39; LE,249)

14. Understands the rise of the major sedentary cultures of Central and South America beginning from the 10th century a.d.

Level III or IV

BD (LE,249)

- Understands the Mayan development of imposing temples, an ideographic writing system, mathematics, astronomical studies, and a calendar more accurate than the European calendar of that time

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BD (LE,250)

- Understands the nature of the Aztec religion, their architecture, governmental system, and accomplishments in developing the pictograph and calendar

BD (LE,250)

- Understands the Incan civilization of the high Andes (e.g., its highly organized governing system, its all-powerful emperor, its systems of communication and trade, its agricultural system of terraced fields)

(BI,29; LE,256-257)

15. Understands the new ways of viewing the world, human nature, arts, learning, and religion of Early Modern Europe between 1450 and 1750

Level III or IV

BD (BI,29; LE,257)

- Understands the artistic, literary, and intellectual creativity of the Renaissance; its origins in Italy; and the nature of Humanism

BD (LE,257)

- Understands the rise of city-states and civic culture in Italy during the 14th and 15th centuries, the role of literacy in commerce and banking as well as in religion, and how certain values of the Italian Renaissance were exported to the rest of Europe

BD (BI,29; GI,39; LE,258)

- Understands the economic, social, and military developments that led to European exploration and conquest

BD (BI,29; LE,259)

- Understands the major theological, political, and economic differences (e.g., the Reformation, the rise of new monarchies) that divided Christians, countries, and classes; and which had long-term repercussions

BD (BI,29; LE,260-261)

- Understands how the successful establishment of absolutism in France under Louis XIV (1643-1715) contrasts sharply with the English Parliament's actions against royal attempts to establish similar power in England

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BD (CI,40; LE,261-262)

- Understands the emergence of modern science, its spread into other realms such as politics and economics, and the application of natural law to human life during the Scientific Revolution and Enlightenment

(LE,262-264)

16. Understands the encounters of Africa and the Americas with Europe after 1450

Level III or IV

BD (LE,253)

- Understands the intercontinental exchanges in goods, plant and animal species, agriculture, precious metals, knowledge, skills and diseases; and their social, economic, and ecological consequences for Europe, Africa, and the Americas

BD (LE,262)

- Understands the complex economic, social, and political effects of the slave trade on African societies

BD (CI,39; LE,263)

- Understands the rise of the Atlantic slave trade as part of an international economic system in which a relatively small number of people, including African kings and merchants along with North and South American planters and European shippers, exploited vast numbers of African and Amerindian workers

BD (LE,264)

- Understands the dynamics of European conquest of the Americas, of the colonial societies that developed, and of the complex racial and cultural intermixing that went on during the colonial period of Central and South America

(LE,266)

17. Understands developments in China and Japan during the Early Modern Era (1450-1750)

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BD (LE,255)

- Understands China's maritime superiority to Europe under the Ming dynasty and the consequences of suspending its seafaring expeditions and returning to isolationism

BD (LE,255)

- Understands the causes of China's dynamic economic development, and how it improved the lives of peasants

BD (CI,39; LE,255)

- Understands the unification of Japan under the Tokugawa shogunate, the growth of its market economy, and related changes in culture and society, including the closure of Japan to Europeans

(LE,254)

18. Understands the rise of the Ottoman Turk and Moghul Empires after 1450

Level III or IV

BD (LE,254-255)

- Understands Ottoman Turk expansionism in the Middle East, North Africa, and Southeastern Europe, following the defeat of Constantinople

BD (LE,255)

- Understands the nature of Ottoman institutions and society, and the causes of their inability to keep up with rising European power

BD (LE,255)

- Understands the consequences of the Muslim Mongol unification of India, and the religious conflicts that contributed to the Moghul Empire's decline

(BI,30; LE,273)

19. Understands the causes, conditions and consequences of the French Revolution and the democratic revolutions in Latin America after 1750

Level III or IV

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BD (LE,275-276)

- Understands the social, economic, and political aspects of French society in the 18th century

BD (LE,276)

- Understands the several stages of the French Revolution, from the moderate compromise over limited monarchy in 1789-91 through radicalism, reaction, dictatorship, and the return to moderate compromise in 1815

BD (LE,276)

- Understands how revolt in Latin America began in the areas of newer development along the eastern seaboard, in the former fringe areas, and then spread to the more settled regions of older development

BD (LE,277)

- Understands that the revolts were led by local elites who wanted freedom from European power but were not eager to disturb their own positions atop the social hierarchy

BD (LE,277)

- Understands that, following these revolutions, Latin America remained under the economic dominance of Europe, had great disparities in the distribution of wealth, and made strides toward industrialization in the form of factories and railroads

(BI,30; LE,277)

20. Understands the transformation of the modern world's economy during the Industrial Revolution after 1750

Level III or IV

BD (LE,277)

- Understands the development of fundamental industrial processes in England during the 18th century, their spread to the European continent and America during the 19th, and the changing nature and further spread of industry in the 20th century

BD (LE,277)

- Understands the systems of transportation and communication that rapidly linked the industrial world, its markets, and the resources of the non-industrialized world in growing systems of economic exchange

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BD (CI,40; LE,278)

- Understands the social and economic effects that followed the changes brought about by industrialization (e.g., the impact on the family, on women and children, and on artisans; the formation of working classes and labor movements; the role of capitalism, banking, and trade in the growth of industrial economies)

BD (CI,40; LE,277)

- Understands the fears raised by industrialization and the reactions to it by the Romantic Movement, the Luddites, and several social classes

(BI,30; LE,278)

21. Understands the ideologies of modern European societies, and their economic, political, and social relationships between 1750 and 1914

Level III or IV

BD (CI,40; LE,278)

- Understands the supporters, the main political ideas, and the economic and social programs of the major 19th century ideologies (e.g., Conservatism and Liberalism, radical republicanism, the several forms of socialism)

BD (CI,40; LE,279)

- Understands the forms of nationalism, including the militant nationalism of the 19th century which was laced with Social Darwinism, racism, and militarism

BD (LE,279)

- Understands the consequences of the 19th century ideologies (e.g., the unifications of Italy and Germany; the subjugation or annihilation of other, "lesser" peoples

(LE,281)

22. Understands the colonial experience of Africa after 1750

Level III or IV

BD (LE,280)

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- Understands 19th century developments in the economies of Africa and how the lives of African peoples became bound up with the rapidly changing global economy

BD (LE,281)

- Understands the important events of the 19th century in Africa, including the Islamic reformation and revolution in West Africa, the rise of Shaka and the Zulu empire, and the appearance of new "gunpowder kingdoms" in East Africa

BD (LE,281)

- Understands the major colonial systems (e.g., British, French, Dutch) and their policies on such points as education, labor recruitment, taxation, economic investment, and civil and political rights for the governed

BD (CI,40; LE,281)

- Understands the disruptions of African life that colonial policies produced and the African responses, particularly in South Africa

(LE,282)

23. Understands the period of British domination in India before 1914

Level III or IV

BD (CI,40; LE,282)

- Understands the emergence of the East India Company as the pre-eminent power in India, efforts by the Indians to recover control, and the consolidation of British rule

BD (LE,282)

- Understands the educational role of British reforms and reformers (e.g., Christian, Utilitarian, Liberal) in India

BD (LE,282)

- Understands the negative side of the Industrial Revolution in transforming India's economy (e.g., the displacement of millions of handspinners and weavers, the depression of local economies)

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BD (LE,282-283)

- Understands the birth and development of Indian nationalism and the problems of nationalist leaders associated with Indian pluralism and with India's provincial, linguistic, and cultural diversity

(LE,283)

24. Understands changes in the Middle East in the 19th century

Level III or IV

BD (LE,283)

- Understands Middle Eastern attempts to emulate Europe in military strength, industry, technology, and in the modernization of governmental systems

BD (LE,284)

- Understands the Middle East's new relations with Europe, arising from Europe's search for export markets and raw materials, as well as the weakening of the Ottoman Empire

BD (LE,284)

- Understands how after wars, Europe frequently imposed treaties in Third World countries, enforcing low tariffs on imported goods which caused a resentment toward the West continuing to the present day

BD (LE,284)

- Understands the importance of various intellectual trends that developed in the Middle East since the mid-19th century (e.g., women's rights, reinterpretations of Islam, constitutional movements)

(LE,285)

25. Understands Japan's acceptance and China's resistance to technological and economic change, and the political changes of both between 1750 and 1914

Level III or IV

BD (LE,285)

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- Understands the "opening" of Japan and how Western civilization replaced Chinese civilization as the dominant outside influence in Japanese life

BD (LE,285)

- Understands the events by which the Japanese emperor was once again placed at the center of the state, creating a powerful, centralized oligarchic rule

BD (LE,285)

- Understands how industrialization proceeded in Japan under the reform impulses of the aristocratic, military, and business elite that dominated imperial politics

BD (LE,285)

- Understands the profound social and cultural consequences industrialization had for Japan

BD (LE,286)

- Understands that while resisting industrialization, the imperial dynasty of China had grown too weak to control unrest and uprisings in its own population, or to force out growing Western influence

BD (LE,286)

- Understands the forcible opening of China to Western Imperialism as a result of wars between England, France, Germany, Russia, and Japan, and its consequences

(BI,30; LE,289)

26. Understands the origins and consequences of the First World War and the Bolshevik Revolution, and the development of totalitarianism in Europe after 1914

Level III or IV

BD (LE,293-294)

- Understands the underlying causes that permitted the assassination of an archduke of the ruling Hapsburg family to embroil an entire continent in war

BD (LE,294)

- Understands the impact of military technology upon the origins of war as well as upon the war itself

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BD (LE,294)

- Understands the conditions confronting the negotiators of the Paris Peace Conference, and the terms of the peace treaty

BD (LE,295)

- Understands how the outbreak of war in 1914 cut short the beginnings of the Russian parliamentary system born of the Revolution of 1905, and understands the immediate causes of the Spring Revolution of 1917

BD (LE,296)

- Understands the political, economic, and social problems the Weimar Republic was unable to solve (e.g., restore national power and prestige, maintain a workable democracy, overcome inflation and depression)

BD (CI,41; LE,289-290)

- Understands the tenets of Marxist/Leninist and Fascist/Nazi ideologies, methods in the seizure of power in Russia and in Germany, and the consequences of the Stalinization of Russia and of Nazism in war and genocide

(BI,30; LE,290)

27. Understands the causes, participants, scope, and consequences of WWII, and important postwar developments

Level III or IV

BD (LE,297)

- Understands the reasons for the passivity of the democracies (British, French, and American) in the face of aggressions by Japan, Italy, and Germany

BD (LE,297)

- Understands the course of the war, how and where it was fought, and the major phases of the war

BD (LE,298)

- Understands the wartime meetings of Churchill, Roosevelt, and Stalin at Tehran (1943) and Yalta (1945), and their agreements concerning postwar international security

BD (LE,298)

- Understands the effects of the war in the division of Germany and the establishment of the Soviet Union's sphere of influence in Eastern Europe and Asia

BD (LE,300)

- Understands the Cold War tensions that escalated during the postwar years, including the overwhelming presence of Soviet armor and troops in Eastern Europe, the crisis of the Berlin Blockade and the building of the Berlin Wall, and the counter-presence of NATO's nuclear force in Europe

BD (LE,301)

- Understands the major currents of scientific thought and developments in the spheres of culture, philosophy, and religion (e.g., the works of Freud, Curie, Einstein, Picasso, Yeats, Joyce; Vatican II, Martin Buber)

(LE,302)

28. Understands important 20th century developments in Japan and China

Level III or IV

BD (LE,302)

- Understands the course of events in East Asia from Japan's imposition of its "21 Demands" on China during WWI to its invasion of Manchuria and Northern China in 1937, as well as other factors that led to its involvement in WWII

BD (LE,303)

- Understands Japan's economic and technological boom of the 1960's, and how the prominence of Japan in trade and world affairs continues to have a profound impact upon both the Japanese and American ways of life

BD (LE,303)

- Understands the failure of the republican reform movement in China, the consequences of the 1911 Revolution, Japan's 15-year occupation, the Chinese civil war, and the establishment of the People's Republic of China

BD (LE,304)

- Understands the costs and contributions of Maoist Communism in China (e.g., the record of public health and agricultural output, its effects on the family and the lives of peasants)

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(LE,304)

29. Understands the forces that have shaped the Middle East in the 20th century

Level III or IV

BD (LE,304-305)

- Understands the division that developed between those who identified with the borders of the many new states that had been set up mainly by the British and French, and those who identified with a larger pan-Arab nationalism; and the different outcomes in countries such as Turkey and Iran

BD (LE,305)

- Understands how the discovery of oil by the British in Iran in 1908 has subjected the Middle East to more outside interference than any other region of the world

BD (LE,305-306)

- Understands the consequences of the creation in 1948 of the new state of Israel, including the continued refusal of most Arab states to recognize the legitimacy of Israel, and the problems raised by Israeli military occupation of Palestine

BD (LE,306)

- Understands that Islam can and has been interpreted differently in different times and places, which has caused conflict, but that much of what has happened in the Middle East can be explained by factors such as ecological decline, and the disruption and dislocation of traditional societies

(BI,30; LE,307)

30. Understands the process of decolonization in Africa and India in the mid-20th century

Level III or IV

BD (LE,307)

- Understands the large-scale movements in Africa to terminate the colonial order, and how before relinquishing their colonies, the French and British instituted European-style governing legal systems which many new nationalist leaders rejected

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BD (CI,41; LE,308)

- Understands the economic and political problems, as well as popular movements of political reform, and the social and cultural life of Africa

BD (LE,308-309)

- Understands the failure of the British government's introduction of constitutional reform and the roles of Indian leaders such as Mahatma Gandhi, Jawaharlal Nehru, and M. A. Jinnah in the struggle for independence

BD (LE,309)

- Understands the continuing modernization and reversion to traditional ways that have characterized the independence of India and the establishment of Pakistan as a separate state

(LE,309)

31. Understands the quality of life of the citizens of Latin American countries, and the role of Latin America in world politics and economics in the 20th century

Level III or IV

BD (LE,309)

- Understands how the United States gradually replaced Europe as Latin America's major trading partner, and how the dynamics of trade channelled Latin American economic growth in particular directions

BD (LE,310)

- Understands that each Latin American country has its own history and traditions which help to determine its present-day policies

BD (LE,310-311)

- Understands the search for self-identity which has fueled politics and revolution, and led to many intellectual and artistic achievements in Latin America

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10. Geography

The following process was used to identify the standards and benchmarks in this category.

Identification of National Reports
Four reports were identified as important documents representing current thinking on standards within geography: a draft of National Geography Standards (June, 1993) from the Geography Education Standards Project; the Geography Assessment Framework for the 1994 National Assessment of Educational Progress from the NAEP Geography Consensus Project; Guidelines for Geographic Education from the Association for American Geographers and the National Council for Geographic Education; and K-6 Geography: Themes, Key Ideas and Learning Opportunities, published by the Geographic Education National Implementation Project.

Selection of the Reference Document
The Geography Education Standards Project's draft National Geography Standards (June, 1993) was selected as the central document. The Project has broad-based representation and was brought together for the express purpose of composing standards for geography. The project also makes use of the other important documents in the field (for further details, see the geography discussion under Section 2).

Identification of Standards and Benchmarks
The Standards draft had several aspects that were amenable to our model for standards development. The standards statements within the document were expressed at a level of generality that fit within our model for standards. Also, beneath each standard there was clearly an effort to describe the essential knowledge and skills students should have in geography and across a range of related or relatable subject areas.

There were a number of areas in which the document was not directly compatible with our approach. For example, the items under each standard in the draft describe knowledge and skills expressed as activities or tasks; this was done because in this draft the "authors... are concentrating on students' ability to use higher-order thinking processes" (p. 3). As a result, most activities describe a scenario in which knowledge or skills in geography are couched in a task that requires some thinking skill: hypothesis, induction, evaluation, problem solving, etc. It is not clear what criteria were used to determine that any given knowledge or skill was better suited to one kind of higher-order thinking process over another. But, for our purposes, it was usually possible from a close analysis of the task to discern what the authors' considered to be essential *geographic* knowledge or skill. Each activity, then, was studied to determine the knowledge or skill that might be presumed from a successful completion of the task. This analysis allowed us to generate benchmarks that describe declarative, procedural and contextual content knowledge.

Another area of divergence between our model and the reference document concerns the range and number of benchmark levels. That is, the Project's draft specifies three benchmark levels: k-4, 5-8, and 9-12. Our model recommends four; roughly corresponding to primary, upper

elementary, middle and high school. In this case, then, completion of our benchmark levels depended upon an analysis of supplementary materials that could provide us with further benchmark information, especially at the primary grades (discussed below).

An additional area of difference in approach arises because "inasmuch as each standard is synthesizing and integrative, the 18 standards necessarily overlap internally" (Geography Standards draft, page 3). Evidence of this overlap appears when very similar benchmark activities are found under two or more standards. As we noted in our discussion of standards and categories (Section 3), boundaries between standards can be fuzzy; but here they are deliberately so. Since we consider the value of identifying subject-area content to rest in part on the parsimonious listing of knowledge and skills, the presence of duplicate benchmarks under different standards does not conform to our model. As a consequence, all duplicates were identified and either deleted from the document or flagged as duplicates within the document. Items were deleted when duplication was clear, and when it was clear which of the standards was the more appropriate heading. For example, under the first standard, "How to use maps, globes and other tools..." is found:

- The student... identifies the four hemispheres on different projections, including flat map projections.

While under standard 2, a standard that focuses on student's knowledge of location one performance includes:

- The student ... identifies hemispheres on maps and globes.

In order to avoid this duplication, we considered the ability to interpret map projections as a skill important in the general use of maps and globes, not simply restricted to the ability to identify hemispheres on projections; thus only the skill of interpreting different projections was retained under the first standard. In this way, a benchmark that addresses the student's ability to identify hemispheres on maps and globes appears only once, in standard 2.

Duplicate benchmark items were flagged rather than deleted when the standard under which they were found altered the sense sufficiently so that it was impossible to choose between them. We believed it important that users know, however, that very closely related items existed in the document. For example, under standard 8, "Understands characteristics of ecosystems on earth's surface." the following benchmark appears at Level IV:

BD (NI,77;SE,27;DI,14.4)

- Understands thresholds and limits of tolerance within ecosystems (e.g., how much of a pollutant can be added before water no longer cleanses itself).

While under standard 14, "Understands how Earth's physical and human systems are connected and interact," at Level IV, this benchmark is found:

BD (NI,77; SE,46; DI,8.4)

- Understands the limits of physical systems to absorb human impacts, using the concepts of synergy, feedback loops, carrying capacity and thresholds.

In this case, it appeared that the benchmark under standard 8 clearly dealt with questions related to capacity within an ecosystem, while standard 14 was concerned with understanding important concepts in the study of physical systems, but there was a very closely related idea in both, that is, the capacity of a physical system to absorb the impact of human activity.

In this case, the duplication was flagged. This is noted at the far end of the "citation log": for standard 8, the "DI,14.4" indicates that there is an implied (I) duplicate found at standard 14, level IV; under standard 14, the "DI,8.4" indicates that a duplicate is implied in standard 8 at level IV. (For further information on the coding system see "How to use this document" under Section 4.)

Integration of Information From Other Documents

During the next stage, the supplementary documents were reviewed, both to integrate information into the main document and to confirm our analysis of the reference document. That analysis, as described above, required us to deduce, from descriptions of tasks and activities, the knowledge and skills the authors believed the student should have. The Item Specifications: 1994 National Assessment of Educational Progress in Geography provided us with an independent means to check the accuracy of our analysis.

Another document used to support benchmark statements was K-6 Geography: Themes, Key Ideas and Learning Opportunities. This guide for curriculum development also provided useful information for the elaboration of benchmarks at the primary level. This information was important since the reference document, as noted above, had not isolated the knowledge and skills that might be especially suitable for the early (k-2) grades. Additionally, Guidelines for Geographic Education was analyzed and cited wherever appropriate at the benchmark level. Since page citations are provided for both these documents wherever appropriate, users are afforded easy reference to supporting material.

(NI,71)

1. Understands the characteristics and uses of maps, globes, and other geographic tools and technologies

Level I

BP (GI,13;NI,35;SE,8;TE,15)

- Knows how to orient a map with a directional symbol

Level II

BD (GE,12;NE,35;SE,5;TE,35)

- Knows the basic elements of maps and globes (e.g., title, legend, cardinal directions, grids, principal parallels, meridians, projection)

BC (GI,13;NE,35;SE,5;TI,35)

- Knows when to use a map rather than a globe or a globe rather than a map (e.g., in measuring long distances)

BP (GI,14;NI,34;SE,5;TE,28)

- Knows how to interpret aerial photos and maps (topography)

BP (GI,13;NE,36;SE,6;TE,27)

- Uses number-letter grids to plot absolute location

Level III

BC (NI,54;SE,6)

- Uses latitude and longitude coordinates to plot locations of physical and human sites (e.g., major cities, natural disasters, mountain ranges, deserts)

BD (NE,37;SE,6)

- Understands concepts such as axis, major parallels, seasons, rotation, revolution, great circles (Earth-Sun relations)

BC (NE,52-53;SE,6)

- Knows the purposes and distinguishing characteristics of different map projections, including distortion on flat map projections

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BD (NE,52-53;SE,6)

- Knows the characteristics and uses of cartograms

BC (NE,53;SE,6)

- Knows the advantages and disadvantages of maps, globes, and other geographic tools to illustrate specific data (e.g., population data, presence of a natural resource, energy consumption)

BP (NE,53-54;SE,6)

- Uses different types of scales

BP (NE,52-53;SE,6)

- Uses thematic maps (e.g., population, economic, vegetation)

BC (NE,53-54;SE,6)

- Knows when to use alternative units of measure (miles, kilometers, time, cost, etc.) to compute and compare distance between places

Level IV

BC (NI,71-72;SE,7)

- Understands the advantages and disadvantages in using maps from different sources (e.g., media, business, government, industry, military)

BD (NE,71-72;SE,7)

- Knows the characteristics and uses of geographic technologies (e.g., GIS, satellite imagery, etc.)

BP (NI,71-72,87,89;SE,7)

- Uses atlases, almanacs and gazetteers

(NI,71)

2. Knows the location of places, geographic features and patterns of the environment

Level I

BD (GE,11,12;NI,36;SE,5-6,8,11;TE,11,15,21)

- Knows the location of school, home, neighborhood, community, state and country

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Level II

BD (GI,14;NE,34;SE,8;TE,27,35)

- Knows the location of the Equator, the hemispheres, International Dateline, Prime Meridian, Tropic of Cancer, Tropic of Capricorn, Arctic and Antarctic circles and the North and South Poles

BD (GI,14;NE,34;SE,8;TE,27)

- Knows the seven continents on maps without labels

BD (GI,15;NE,34;SE,8;TE,27)

- Knows selected countries and metropolitan areas on maps or globes

BD (GI,14;NE,34;SE,8;TE,27)

- Knows the Earth's oceans on maps or globes

BD (GI,14;NE,34;SE,8;TE,27)

- Knows the location of places relative to one another (states or provinces, countries, continents, oceans)

BD (GI,15;NI,36-37;SE,8;TE,27)

- Knows the location of places relative to physical features (e.g., New York City is on the Atlantic Ocean)

BD (NE,34;SI,9)

- Knows the location of major agricultural and industrial regions in the United States

Level III

BD (NE,52;SE,9)

- Knows the location of major seas and gulfs

BD (NI,52;SE,9)

- Knows the location of key physical features (e.g., mountain ranges, deserts, forests, rain forests) of the Earth

BD (NI,52;SE,9)

- Knows the location of states and provinces of the United States and Canada

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BD (NE,71;SI,9)

- Knows the location of major cultural features of the world (e.g., Great Wall of China)

Level IV

BD (NE,71;SE,10)

- Knows the location of major landforms, major rivers and major lakes

BD (NI,71;SE,10)

- Knows the location of countries on maps and globes, including capital cities

BD (NE,71;SI,9)

- Knows the location of members of major political, economic, religious, and ethnic groupings

(NI,82)

3. Understands the characteristics and uses of spatial organization of the Earth's surface

Level I

BD (GI,11-12;NI,35;SE,6,11;TE,15)

- Knows the absolute and relative location of a community and places within it (e.g., parks, stores, landmarks)

BD (GI,13;NI,48;SE,11;TI,20)

- Understands that places can be identified by similarities and differences in land use (e.g., urban, rural, residential, commercial, recreational and transportational)

Level II

BD (GI,14;NE,45;SE,11;TI,35)

- Understands the relationships between locations through such concepts as direction, distance (absolute, relative, perceived travel time and cost), interaction, accessibility, and association

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BD (GI,14;NE,45-48;SE,11;TE,38-39)

- Understands how changing transportation and communication technology have affected relationships between locations

Level III

BD (NE,54-57;SE,12)

- Understands distributions of physical and human occurrences with respect to observable patterns, associations, and densities (why some areas are more densely settled than others; relationships and patterns in the kind and number of links between settlements)

BD (NE,69;SE,12)

- Knows factors that influence location decisions (retailers may be influenced by locations near customers, next to a busy store, or on a heavily traveled street; jobs and climate influence people's decisions about where to live; locations of certain economic activities are influenced by natural resources, transportation, and labor)

BD (NE,66;SE,12)

- Understands patterns of land use in urban, suburban and rural areas (land uses that are frequently nearby and others not frequently adjacent to one another; dominant land-use patterns in city centers and peripheral areas)

BD (NI,45;SE,12)

- Understands the different ways that places are connected and how these connections demonstrate interdependence, accessibility, or factors related to distance (e.g., where classmates were born and now live; where sports teams travel to play; imports and exports at different seasons of the year; regions and countries Americans depend on for resources and manufactured goods)

BD (NE,68;SE,12)

- Understands the patterns and processes of diffusion (spread of language, religion, and customs from one culture to another; spread of a contagious disease through a population; diffusion patterns of animals, insects, and plants)

Level IV

BD (NE,83;SE,13)

- Understands principles of location (e.g., why some industries move their plants to developing countries, relationships between distance from market, value of product, and

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agricultural production; relationships between locations of raw materials and markets in different regions)

BD (NE,82;SE,13)

- Understands changing spatial patterns (e.g., shifts in commercial areas; residential areas; land-value patterns)

BD (NE,86-87;SE,13)

- Knows factors that affect the rate and extent of diffusion of natural and cultural phenomena (population density and centers of diffusion; direction of flow; barriers; distance; language; transportation and communication networks; economic and political systems)

BD (NE,82;SE,13)

- Understands the factors that control spatial interaction (e.g., complementarity, transferability, and intervening opportunity) and their impact on flow patterns such as transportation networks, trade and migration patterns, and commodity flows

(NI,76)

4. Understands the physical and human characteristics of place

Level I

BD (GE,13;NE,45;SE,14;QE,22)

- Knows physical and human characteristics of the local community (e.g., neighborhoods, schools, parks, creeks, shopping areas, airports, museums, sports stadiums, hospitals)

BD (GI,14;NE,42;SE,14;TE,22)

- Knows places can be defined in terms of their predominant human and physical characteristics (e.g., rural; urban; forested; desert; or by types of landforms, vegetation, water bodies, climate)

Level II

BD (GI,16;NE,42-43;SE,15;TI,29-30;DI,10.3.3)

- Understands ways that human decisions and activities shape the characteristics of places (e.g., how Bedouins, Mongolians, or grandparents living in Arizona meet their needs in a desert) climate)

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Level III

BD (NE,56-57;SE,15)

- Knows human characteristics of places (e.g., cultural characteristics such as religion, language, politics, technology, family structure, gender; population characteristics; land uses; level of development)

BD (NE,61;SE,15)

- Knows physical characteristics of places (e.g., soils, landforms, vegetation, wildlife, climate, natural hazards)

BD (NE,56-57;SE,15)

- Understands how the interaction of human activities and natural environments produces distinctive places (e.g., variations in culture, economic activities, topography, climate, population, technology)

Level IV

BD (NI,76-79;SE,16;DI,14.4.4)

- Knows ways in which humans change places, (e.g., the agricultural and industrial revolutions)

BD (NE,75;SE,16)

- Understands the effects of such trends as population growth and urbanization on cultural landscapes

BD (NI,74-75;SE,16)

- Understands ways in which size and characteristics of place are related to human activities such as economics (agriculture, fishing, industry, transportation), politics (boundary setting, capital location, division of administrative units), and population (rural-to-urban migration, population expansion or decline, immigration and emigration)

BD (NI,83;SE,16)

- Knows the locational advantages and disadvantages of places based on physical characteristics (e.g., good soil, flood plain, forest, tundra, earthquake zone, coastal flood zone)

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(NI,74)

5. Understands the concept of regions

Level I

BD (GI,12;NI,56-57;SE,17;TE,19-20)

- Knows how a region is divided into areas (e.g., shopping areas and merchandise pick-up areas in a mall; a local neighborhood and a central business district in a community)

Level II

BD (GE,13;NE,38;SE,17;TE,32)

- Knows characteristics of regions (climate, natural vegetation, shopping, housing, manufacturing, landform, religion, language)

BD (GI,13;NI,52-53;SE,17;TI,25)

- Understands reasons for regional boundaries (e.g., physical, economic, political, cultural)

BD (GE,14;NI,38;SE,17;TE,26)

- Understands how regions change over time (e.g., a new shopping center, a regional hospital, a new manufacturing plant, interstate highways, railroads, airports)

BD (GI,14;NE,56-57;SE,17;TE,43)

- Knows reasons for different regional labels and images (e.g., the South, Corn Belt, Chicago Metropolitan Area, the Sun Belt, Chinatown)

BD (GE,12-14;NI,47;SE,17-18;TE,25)

- Understands ways in which regions are connected to one another (e.g., the production of basic items, transportation, communication)

Level III

BD (NI,45;SE,18)

- Knows regions at various scales (e.g., hemispheres, regions within continents, within countries, within cities)

BD (NI,56-57;SE,18;DI,10.3.1)

- Understands criteria that give a region identity (e.g., central focus of a region, physical and cultural characteristics)

BD (NI,56-57;SE,18)

- Understands the effects of regional change (e.g., regions that were characterized in a particular way at an earlier time have very different characteristics today; results of regional change in the daily lives of people)

BD (NI,56-57;SE,18)

- Knows regional subdivisions (how continents, countries, states or provinces, metropolitan areas, suburbs, or neighborhoods are divided based on human or physical characteristics)

BD (NI,56-57;SE,18-19)

- Understands the influences and effects of particular regional labels and images (e.g., the Gold Coast neighborhood of Chicago, the South, the Midwest, the Middle East, Southwest Asia, "developing" vs. "less-developed" regions, "have" vs. "have-not" regions)

BD (NI,56-57;SE,19)

- Understands ways regional systems are interconnected (e.g., watersheds and river systems, regional connections through trade, cultural ties between regions)

Level IV

BD (NI,64;SE,19)

- Understands that changes in the elements of a region (e.g., shifts in population, environment, and political, economic and cultural features) may alter boundaries

BD (NI,74-75;SE,20)

- Understands factors that produce or affect regional labels and images

BD (NI,74-75;SE,19)

- Understands connections within and among regions (e.g., neighborhoods to a city, suburbs to the metropolitan area, a northern hemisphere region to a southern hemisphere region; interacting systems and subsystems of natural environments; physical and human factors involved)

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(NI,79)

6. Understands that culture and experience influence people's perception of places and regions

Level I

BD (GI,13-14;NI,38;SE,20;TI,13)

- Knows various culture groups in a community and their contributions to the development and appearance of that place and region

Level II

BD (GI,14;NI,44;SE,21;TI,23)

- Knows why different people view and relate to places, regions, and issues in different ways (older people may describe changes over time while younger people may see only recent changes; a newcomer may not understand much about a place or region whereas a long-term resident may know the place or region very well)

BD (GI,14;NE,44;SE,21;TE,29)

- Understands ways in which people view similar places or regions differently (e.g., cities as safe or unsafe places; the Great Plains as barren or beautiful)

Level III

BD (NE,62-63;SE,21,27)

- Understands how people's values (based on culture, previous experience, and economic circumstances) affect their perceptions of places and regions (e.g., cities as safe or unsafe places; the Great Plains as barren or beautiful; places or regions as symbols of freedom or oppression)

Level IV

BD (NI,79-80;SE,21)

- Understands why places and regions are important to individual human identity and as symbols for unifying society (sense of belonging, attachment, sense of rootedness)

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BD (NI,79-80;SE,21)

- Understands the causes and effects of ways that different groups in society view places and regions (differences in age, gender, values, and beliefs; differences in socioeconomic backgrounds; stereotyping places, regions, and people on the basis of ethnocentric views)

BD (NI,63;SE,10)

- Understands how people's perceptions of their environment change over time and factors that cause the changes (e.g., population density, land use patterns, new experiences, changing attitudes toward places)

BD (NI,63;SE,10)

- Understands how people's perceptions of their environment influence decisions of location, settlement, and other activities (e.g., decisions to change place of residence, seek a new job, choose a school, or shop in an unfamiliar area; ethnocentric vs. parochial world view)

(NI,73)

7. Knows physical processes that shape patterns on Earth's surface

Level I

BD (GI,11-12;NI,55-56;SE,22;TI,13-17)

- Understands Earth/Sun relationships and their effect on seasons, length of day and weather and climate

Level II

BD (GI,16;NE,37;SE,22;TI,28;DI,8.2.1)

- Knows the physical characteristics of Earth's biosphere (vegetation and biomes), atmosphere (weather and climate), lithosphere (landforms), and hydrosphere (water)

BD (GI,16;NE,37;SE,22;TI,28)

- Understands the relationships among physical patterns and processes (e.g., elevation, climate, natural vegetation, landforms, position relative to the Equator, sea level, and oceans)

Level III

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BD (NE,55-56;SE,23)

- Knows the major processes that shape patterns in the natural environment (e.g., weather; gravity; erosion; ocean currents; tectonic processes such as those that produce earthquakes and volcanoes; earth movements such as landslides, alluvial fans, sand dunes, barrier islands, moraines)

BD (NI,55-56;SE,23;DI,16.2.2)

- Knows the processes that produce renewable and non-renewable resources (e.g., fossil fuels, hydroelectric power, soil fertility)

BD (NI,55-56;SE,23)

- Understands terms that relate to physical patterns and processes (system, boundary, force, circulation, threshold, equilibrium)

BD (NE,55-56;SE,23)

- Understands fundamental concepts of physical geography that explain physical processes (e.g., deposition of sediments on floodplains; formation of canyons, gorges, water falls; landslides, avalanches; global circulation systems of the atmosphere and oceans)

Level IV

BD (NE,73-74;SE,24)

- Knows how patterns of temperature, wind and precipitation are produced by the processes of atmospheric energy, circulation, moisture and other factors that affect climate

BD (NI,73-74;SE,24)

- Understands Earth's physical processes at a global and local scale (e.g., global prevailing wind patterns versus local land and sea breezes, global and local distribution of acid rain or groundwater pollution)

BD (NE,73-74;SE,24,27,44)

- Understands physical cycles such as plate tectonics, carbon cycle, and hydrologic cycle

BD (NI,73-74;SE,24;DI,8.3.4,15.3.1,15.3.3)

- Understands how physical systems are dynamic and interact (e.g., interactions between the Earth-Sun system orbital changes and long-range climate change; relationships between volcanic activity, solar radiation, and climate change; climate conditions and effects on sea level, agriculture and population distribution)

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BD (NE,73-74;SE,24)

- Understands physical processes that affect different regions of the United States and the world (e.g., landform creation and alteration on coasts; processes that affect mountainous regions such as rock slides and avalanches; severe weather conditions; water supply; sources of energy for electricity; physical features that affect transportation; erosional systems in cold regions; physical processes in dry environments such as flash floods, soil erosion, and sand movement)

(NI,73)

8. Understands characteristics of ecosystems on Earth's surface

Level I

BD (GI,12;NI,41-42;SE,26;TI,23)

- Knows how elements of the environment (temperature, vegetation, precipitation) influence our lives

Level II

BD (GI,14-16;NE,41;SE,25;TI,41;DI,7.2.1)

- Knows Earth's natural systems (hydrosphere, lithosphere, biosphere, and atmosphere; environment, ecosystem, biome, cycle)

BD (GI,12;NE,41;SE,25;TI,42)

- Knows possible effects of changes in an ecosystem (changes in rainfall affect crop production; natural disasters such as earthquakes, hurricanes, and volcanic eruptions affect people, vegetation, and animals)

BD (GI,13-15;NE,41;SE,25;TI,43)

- Understands Earth's limited capacity (causes and consequences of increasing animal populations, overgrazing and plowing of arid land, mineral or resource exploitation, waste dumping)

Level III

BD (NI,55;SE,26)

- Knows components and functions of natural cycles (e.g., water, nutrients) and relationships among them

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BD (NE,58-59,60;SE,26)

- Knows ecosystems (e.g., plant and animal life) in various parts of the world

BD (NI,77;SE,26)

- Knows ecological concepts (e.g., energy, cycles, diversity, community, interrelationship, change, adaptation) and how they are evident in the world's biomes

BD (NE,60;SE,26;DI,7.4.4,15.3.1,15.3.3)

- Understands local to global ramifications of changes in an ecosystem (consequences of building a dam on a free-flowing river in relation to wildlife habitats, vegetation cover, and the control of flooding downstream; effects of major natural events, such as storms and floods, on the lives of individuals and communities; effects of climate on people in different areas of the world)

BD (NE,42;SE,26)

- Understands that the environment has limited capacity to absorb the impacts of human activity (habitats of endangered species and causes of species endangerment; why governments impose laws that regulate human use of preserved areas and animals; effects of human activity on the flora and fauna of a community)

Level IV

BD (NI,73-74;SE,27)

- Understands specific ecological concepts (e.g., energy flow between producers and consumers; diversity in a plant community; relationships between the flora and fauna and the land, water, and air in a biome; how the laws of thermodynamics and conservation of matter apply to the environment)

BD (NI,73;SE,27)

- Understands interrelationships in ecosystems (e.g., fertilizer used on lawns, leachate in a landfill)

BD (NI,77;SE,27;DI,14.4.3)

- Understands that ecosystems hove thresholds and limits of tolerance (e.g., how much of a pollutant can be added before water no longer cleanses itself)

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(NI,86)

9. Understands the nature, distribution, migration and movement of human populations on Earth's surface

Level I

BD (GI,15-16;NI,49;SE,28;TI,19)

- Knows short distance, daily movement patterns (e.g., how people get to school and stores; different ways people commute or travel about the city or countryside each day)

Level II

BD (GE,13-14;NI,38;SE,28;TE,22)

- Understands the characteristics of populations (e.g., ethnic background, religion, gender, age)

BD (GI,12-13;NE,66;SE,29;TE,30)

- Knows ways in which transportation and communication systems have changed and the effects of such changes on human population patterns

BD (GI,16;NI,49-50;SE,29;TI,43;DE,17.4.2)

- Understands factors leading to past and present migration patterns (e.g., reasons for large-scale migration of several groups such as European colonists and African slaves to America; effects of physical geography on national and international migration)

BD (GI,15-16;NI,49;SE,29;TE,32)

- Knows ways in which population movement and migration influence the character of a place (e.g., how growing populations have resulted in changing transportation patterns; how the movement of ideas, products, and people can influence other world areas)

Level III

BD (NE,74-75;SE,29)

- Understands demographic concepts and how they are related to population characteristics of a country or region (e.g., birth rates, death rates, population growth rate, doubling time, life expectancy, average family size, average age)

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BD (NE,68-69;SE,30)

- Knows factors that influence patterns of rural-to-urban and intra-urban migration (e.g., urban commuting; effects of technology on transportation, communication, and people's mobility; barriers that impede the flow of people, goods, and ideas)

BD (NI,68-69;SE,30)

- Understands concepts related to migration such as "push and pull" (political, economic, religious forces), "opportunities," and "obstacles"

BD (NI,56-57;SE,30)

- Understands the ever-changing nature of population patterns and the effects of these changes (e.g., environmental change; positive and negative consequences for a place; the spread of culture traits and diseases)

Level IV

BD (NI,78-79;SE,30)

- Understands population problems and possible effects of future changes in population patterns (e.g., environmental changes such as global warming, desertification; socio-cultural such as political conflict, growth of ethnic enclaves; and social such as increased waste production, attitudes toward new immigrant groups, overcrowding, government programs designed to alter population characteristics in response to perceived problems)

BD (NI,74-75;SE,31)

- Understands patterns of mobility (e.g., landscape features that facilitate daily circulation within and among regions; connections between and among rural areas and urban places; ways to improve mobility in an area while reducing negative impacts)

BD (NE,68-69;SE,31)

- Understands the economic and social linkages that relate to human mobility and migration (effects of the U.S. highway system; effects of political, economic, and religious pushes and pulls; effects of mental maps, intervening obstacles, and feedback)

BD (NI,74-75;SE,31)

- Knows physical and cultural landscape changes in population patterns (e.g., results of migration such as churches, cultural centers; examples of cultural diffusion and economic impact; changes in land value)

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BD (NI,74-75;SE,31)

- Understands the dynamic nature of population distribution patterns (e.g., current trends, reasons for changes and patterns, impacts)

BD (NI,87;SE,31)

- Understands the significance of daily commuting patterns (e.g. problems caused by daily commuting patterns; modes of transportation in different countries; ways transportation systems have changed to accommodate the relocation of businesses, industry, or social services)

(NI,75)

10. Understands the nature and complexity of Earth's cultural mosaics

Level I

BD (GI,14;NI,46;SE,32;TE,10)

- Understands how habits and styles of life are acquired from parents and other family members, friends, teachers, the media, and other sources.

Level II

BD (GI,14;NE,44;SE,32,45;TI,13)

- Understands different uses of similar environments by different societies

BD (GI,14;NI,46;SE,32;TI,13)

- Understands that culture is the way groups of people think, act, and work that is transmitted from one generation to another, and that customs are parts of a culture (e.g., terms of address, clothing styles, religious rituals)

BD (GI,14;NI,46;SE,32,TI,13)

- Understands the difference between material (e.g., tools, clothing) and non-material (e.g., ideas, beliefs, language) culture, and ways these are expressed in various places

BD (GI,14;NE,44,49;SE,32;TI,31-32)

- Understands how societies change (e.g., technological innovations and inventions, cultural diffusion, assimilation, acculturation, movement of people from one place to another)

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BD (GI,14;NI,44;SE,32;TI,13)

- Understands how a value system influences what is important to a group (e.g., the animistic beliefs and sense of custodial responsibility of some native American groups that reflect the importance of the natural environment)

BD (GI,14;NI,44;SE,11,32;TI,32)

- Understands patterns of culture across the world (e.g., distribution of religions and languages, the migration of people)

Level III

BD (NE,56,57,61;SE,33;DI,5.3.2)

- Understands the world's major culture regions and the cultural criteria used to influence regional boundaries (e.g., cultural phenomena, land use, language, technology, economic activity, population density in specific regions)

BD (NE,57,60,61;SE,33;DI,14.3.3)

- Understands the adjustments traditional and modern societies make to their physical environments (the increased use of coal as an industrial fuel in 19th century Europe and the U.S. significantly altered landscapes in Wales, the Appalachians, and the Ruhr Valley)

BD (NI,61;SE,33;DI,4.2.1)

- Understands how human occupance patterns differ in similar physical environments (e.g., the adaptations of the Lapps and Inuit to similar Arctic landscapes, or the uses of desert regions by Mongolian nomads in the Gobi and Berbers in the Sahara)

BD (NE,63;SE,33)

- Understands the role of technology in helping to define a human group's style of life (the impact of the auto, perceptions of resources)

Level IV

BD (NE,75;SE,19,33)

- Understands the historical roots of culture realms, their common human characteristics, and key aspects of their physical environments (e.g., separatism in French Canada, the consequences of deforestation on the migration of Haitians to the U.S., efforts to establish a Palestinian state)

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BD (NI,75;SE,34)

- Understands how political and economic alliances may affect the traditional cohesiveness of the world's culture realms

BD (NI,75;SE,34)

- Understands how changes (e.g., political, economic) in one part of the world can have an impact on people in distant places

(NI,75)

11. Understands the patterns and networks of economic interdependence on Earth's surface

Level I

BD (GI,12;NI,38;SE,34;TI,15,18)

- Understands economic land use in a community (e.g., industrial, commercial, recreational) and patterns of economic activity in an urban area (e.g., a central business district, industrial areas, malls)

BD (GI,12;NI,45;SE,35;TE,14,19)

- Understands origin-and-destination networks apparent in everyday life (e.g., relationship between long-distance phone calls, rates, and distance; relationship between distance and frequency of trips; the origins of food, clothing, and household items)

BD (GI,12;NI,43;SE,35;TI,10,18)

- Knows the different modes of transportation used to move people and products (e.g., barges, airplanes, automobiles, pipelines, ships, railroads), their importance, and their advantages and disadvantages

Level II

BD (GI,15;NI,39,46;SE,35;TI,29,33,39)

- Knows the boundaries of primary economic activities (e.g., agriculture, mining, fishing) and the importance of these activities

BD (GI,15;NI,38,40,46;SE,35;TI,31)

- Understands the spatial aspects of systems to deliver goods and services (e.g., the origin-destination flow of products, major U.S. imports and exports and trading partners, the causes and consequences of world trade interruptions)

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BD (GI,15;NI,38,41,46,48;SE,35;TI,37)

- Understands issues related to the spatial distribution of economic activities (e.g., the relationship between jobs and migration; a large factory or other economic activity moves to another place)

BD (GI,15;NE,41;SE,5;TI,37)

- Understands the relationship between the physical environment and the economy of a region (e.g., the relationship between soybean production in the Midwest and rainfall)

Level III

BD (NI,65;SE,35)

- Understands patterns of primary economic activity in the U.S. and elsewhere (e.g., national and global markets, the relationship between agricultural regions and food-processing industries, governmental economic programs)

BD (NI,59,65-67,70;SE,35-36)

- Understands how geography, the factors of production, and economic theories have played a role in the location of American industry (rise and persistence of the American "Manufacturing Belt," evolution of *maquiladoras*; the many American industrial jobs that have been exported to other countries; the choice of other countries to move industrial operations to the U.S.)

BD (NI,65,69;SE,36)

- Understands the relationship between economic factors and national and global migration patterns (slaves, guest workers, seasonal or migrant labor)

BD (NI,69;SE,36)

- Understands the structure, function, and issues of cities and other settlement types with respect to provision of goods and services (e.g., gentrification, ghetto, poverty, public transportation, hierarchy of central places, concentric growth)

BD (NI,59,69;SE,36)

- Understands the primary causes and the major elements in the system of world trade (e.g., comparative advantage, tariffs, protectionism, free trade)

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BD (NI,57;SE,36)

- Understands historic and contemporary patterns of origin-and-destination networks (e.g., triangular trade routes of the 16th and 17th centuries; migration patterns; economic relationships between colonies and motherlands)

BD (NI,66;SE,36,45)

- Understands historic and contemporary systems of transportation and communication (e.g., canals, major world ports, air freight, telegraph, satellites), how they have changed and improved over time, and how they have affected patterns of economic interaction

BD (NI,75;SE,37)

- Understands issues related to economic development which involve the technologically advanced and developing worlds (e.g., population growth, consumption and waste generation patterns, environmental quality)

Level IV

BD (NI,71,74;SE,37)

- Understands the distribution and attributes of major economic systems (e.g., communism, capitalism) and problems associated with the shift from one system to another

BD (NI,75;SE,37)

- Understands systems of movement and economic activity (e.g., the development of mercantilism; reasons for and patterns of trade routes before and after the beginning of the 20th century; sources and flow of raw materials; organization and use of land that encouraged a system of monoculture)

BD (NI,75;SE,37)

- Understands what determines residential, commercial, and industrial land values, and the relationships between land values and prominent urban features (e.g., central business districts, freeways, residential zones, productivity)

BD (NI,75;SE,37)

- Understands the current validity of land-use theories developed long ago

BD (NI,75;SE,38)

- Understands private-sector economic systems (e.g., location and profitability, market areas created by the media, consumer travel behavior and market areas around major businesses)

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BD (NI,75;SE,38)

- Understands public-sector social service delivery systems (e.g., equity issues, access to medical care, response time of emergency vehicles)

BD (NI,75;SE,38)

- Understands causes and effects of multinational activities in the world (Third World loans; allowing foreign-owned businesses to purchase land, open factories, or conduct other business in the U.S.; use of military conflicts to protect economic interests)

(NI,75)

12. Understands the patterns of human settlement and their causes

Level I

BD (GI,12;NI,38-39;SE,38;TI,14)

- Knows the similarities and differences in population distributions within a community

Level II

BD (GI,13;NI,38-39;SE,39;TE,21)

- Understands why people choose to settle in different places

BD (GI,14;NI,38,48;SE,39;TI,29,32)

- Understands that differences in population size and density are related to patterns of landform (e.g., floodplains, river valleys, coastal zones), climate, and vegetation

BD (GI,14;NI,38,48;SE,39;TI,29)

- Knows areas of dense human settlement in the middle latitudes (e.g., northern India, parts of Western Europe) and why they are densely populated (e.g., access to transportation, fertile soils, flat land)

BD (GI,14;NI,38,48;SE,39;TI,29)

- Knows areas of sparse human settlement (e.g., the Andes, the Arctic) and why they are sparsely populated (e.g., mountainous land, extreme climate)

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BD (NI,52,60;SE,39)

- Understands ways that urban and rural planning (e.g., zoning and other government rules and regulations, property owners' rights, people's preferences) influence patterns of settlement

BD (NI,57,59;SE,39;DI,17.3.4)

- Understands the relative advantages of certain locations for the growth of cities (fertile floodplains in middle latitudes and on coastal plains)

BD (NI,52,57,65;SE,39-40)

- Knows similarities and differences in various settlement patterns of the world (residential areas, rural and urban areas, transportation arteries, industrial and commercial areas, recreational areas, similarities to his/her own community)

Level IV

BD (NI,82;SE,40;DI,14.3.4)

- Knows the different types of land use in settlements

BD (NI,75;SE,40)

- Understands the ways settlements remain the same or change over time

BD (NI,75;SE,40;DE,18.4.1)

- Knows similarities and differences in settlement characteristics of economically developing and developed nations (characteristics of cities, the dispersion of settlement in rural areas, residential patterns, transportation patterns)

BD (NI,75;SE,40)

- Knows the consequences of factors such as population changes, new transportation arteries, and the arrival or departure of a large factory or other large employer on the settlement patterns of an area

BD (NI,75,87;SE,40;DI,17.3.5)

- Understands the characteristics of ethnic neighborhoods in a city and the settlement patterns of new immigrants

BD (NI,75,87;SE,40)

- Understands how settlement patterns can reveal differing cultural backgrounds (e.g., plants, foods, building styles, recreational facilities, ethnic enclaves)

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(NI,85)

13. Understands forces of cooperation and conflict that shape the divisions of Earth's surface

Level I

BD (GI,14;NI,48;SE,41;TI,30)

- Knows why people cooperate or engage in conflict to divide spaces (local groups might cooperate to use a park or a recreation field; a neighborhood might oppose the construction of a new highway)

Level II

BD (GI,12;NI,36;SE,41;TI,22)

- Understands different local spaces in terms of their relationships to economic, political, and social activities (e.g., convenience store as economic space, police station as political space, church as social and cultural space)

BD (GI,14;NI,48;SE,41;TI,27)

- Knows political units at different scales (e.g., towns, counties, states), how they are separate, and how they are interrelated

BD (GI,13;NI,38;SE,41;TI,27)

- Understands why Earth is divided into so many countries

Level III

BD (NE,67;SE,41)

- Knows the locations of major political conflicts

BD (NE,67;SE,41-42)

- Understands factors that contribute to cooperation (e.g., religion, language, a regional planning commission) or conflict (e.g., resources, political beliefs, cultural differences, desire for self-rule) within and between regions and countries

BD (NI,67;SE,42)

- Understands divisions of the earth's surface that result from cooperation or conflict among people

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BD (NI,52,67;SE,42)

- Knows social, political, and economic divisions on Earth's surface at local, state, national, and international levels (e.g., world religions; political alliances; franchises, branches, and regional districts within large economic organizations)

Level IV

BD (NI,85-86;SE,42)

- Understands local community groups' use of social, economic, and political space

BD (NI,52,67;SE,42)

- Understands conflict and cooperation leading to division of space (e.g., formation of regional planning districts, regional school districts, boundaries of countries treaty establishing a free-trade area)

BD (NE,86;SE,42)

- Knows the causes of boundary conflicts and internal tensions between culture groups

BD (NI,85;SE,42)

- Understands that changes in the distribution of congressional districts of states in the United States depends on the spatial distribution of population

BD (NI,85-86;SE,42)

- Understands how changes in the political, social, and economic divisions of Earth's surface occur (e.g., rise and fall of an imperial power)

BD (NI,85;SE,42)

- Understands why some nation-states are landlocked (e.g., wars between rival states, distribution of cultural groups)

BD (NI,79,85;SE,42)

- Understands the Law of the Sea Treaty and reasons for dividing the world's oceans among nations (e.g., use of living and non-living marine resources, control over and access to water passages)

BD (NI,85-86;SE,42)

- Understands how regional differences influence prospects for conflict and cooperation

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(NI,76)

14. Understands how Earth's physical and human systems are connected and interact

Level I

BD (GI,12;NE,40;SE,43;TI,22)

- Knows the functioning of a community as a system in terms of flows of people (commuting), movements of goods and traffic, and exchanges of ideas through media such as newspapers and television

BD (GI,16;NE,40;SE,43;TI,13)

- Knows how elements and properties of physical and human systems work together and separately (farms and interactions of soils, weather and climate, and markets; clearing forests; removing rocks; domesticating plants and animals; using fertilizers; irrigation)

Level II

BD (GE,14;NI,42-43;SE,25-26,43;TE,29-30)

- Knows ways people adapt to or modify the environment (e.g., shelter, fences, irrigation projects, dams, terrace farming, settlement patterns and urbanization)

BD (GE,14;NI,43;SE,47;TI,38)

- Understands relationships between technology and human modifications to the environment

Level III

BD (NI,60-61;SE,44)

- Understands that humans depend on and get feedback from natural and physical systems

BD (NI,60;SE,45)

- Knows the effects of physical events (earthquakes, volcanic eruptions, hurricanes, tornadoes) on humans and on their perceptions of the environment

BD (NI,62,65;SE,45;DI,10.3.2)

- Understands different natural environments in terms of opportunities and constraints for different groups at various levels of technology and economic development

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BD (NI,56-57;SE,45;DI,12.4.1)

- Knows major kinds of land and resource use associated with agriculture, manufacturing, forestry, mining, urbanization, and transportation (distribution of the land use, major factors influencing its location, resources the land use depends upon)

BD (NI,58-59,61;SE,44-45,57)

- Understands factors that cause physical and human systems to change over time (land use, technology, economic systems, population growth, etc. have led to changes in the atmosphere; urban-to-rural migration changes the number and density of people in a city)

BD (NI,60;SE,45)

- Understands the influence of the natural environment on urban development (the relationship between soil type and land form and building-type, or between earthquake hazard and construction practices)

Level IV

BD (NE,76-77;SE,45;DI,4.4.1)

- Understands cause-and-effect relationships in physical and human systemic interaction (how the systematic oscillations in the El Nino/La Nina affect climate, agriculture, ocean currents, fish, the fishing industry, supplies of fertilizer, and agricultural productivity)

BD (NE,78;SE,45,49)

- Understands how people have attempted to limit damage from natural system events and how people who live in hazardous areas adapt to their environment

BD (NI,77;SE,46;DI,8.4.3)

- Understands the limits of physical systems to absorb human impacts, using the concepts of synergy, feedback loops, carrying capacity, and thresholds

BD (NI,77-78;SE,46;DI,4.4.1)

- Knows how human actions have altered the natural environment, and how current use patterns may affect possible future issues (changes in land-use patterns, environmental significance)

BD (NI,84;SE,46)

- Understands how changes within human and physical systems can slow or accelerate systemic processes (how hoarding in a time of scarcity affects the supply of the scarce resource, exacerbating the scarcity; how increases in human population stress physical

and human systems which, in turn, worsen conditions; how patterns of consumption affect the generation of waste materials)

BC (NI,77-78;SE,49)

- Knows how to select valid criteria to measure the level of human modification of the natural environments in different regions (urbanization, percentage of the labor force in manufacturing, consumption of energy per person, transportation and communication facilities per person)

(NI,77)

15. Understands the consequences of the interactions between human and physical systems

Level II

BD (GE,14;NE,43;SE,47;TI,29-30)

- Knows appropriate concepts and vocabulary used to describe the impact of technology upon the environment (increase of pollution in the air; land and resource degradation; limits and carrying capacity of different environments)

BD (GI,16;NE,42;SE,47;TI,31)

- Understands the varying ability of physical systems to absorb the effects of human activity (area under the swing set, paths produced by dogs in yards, habitats of endangered species, the Dust Bowl, the Sahel)

BD (GI,15;NE,43;SE,25,44,47,56;TE,30)

- Knows ways human systems affect physical systems, and the positive and negative outcomes (herbicides, fertilizer and pesticides affect water; irrigation leads to salinization; increased urbanization affects distribution of forested land)

Level III

BD (NE,60-61;SE,26,48;DI,7.4.4,8.3.4,15.3.3)

- Understands how contemporary land use and other human activity affect physical systems (the effects of farming, forestry, fishing, and transportation on air, land, water, vegetation, and other species; the effects of population growth on waste generation and disposal; effects of war)

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BD (NE,61-62;SE,48)

- Understands the positive and negative effects of technology on human interaction with physical systems (effects of industrialization and agribusiness on quality of life; intended and unintended outcomes of technological changes such as automobiles, freeways, nuclear energy, steel-tipped plows), and ways these effects could be ameliorated

BD (NI,60-61;SE,44,48;DI,7.4.4,8.3.4,15.3.1)

- Knows the consequences of changes in a physical system on a human system or another physical system (changes in the climatic system in mid-latitude grasslands cause drought and threaten human uses of the environment; building a dam on a free-flowing river affects wildlife habitats, vegetation, and the need for water or control of flooding downstream; how environmental change in one part of the world can impinge on other parts of the world)

Level IV

BD (NE,78;SE,26,46,49)

- Understands the consequences of human modification and transformation of the environment, and possible future issues arising from current use patterns (effects of building frontier settlements and highways in Amazonia; movement of retirees into rural areas; clearing slopes for ski runs; urbanization or suburbanization at the fringe of settlement)

BD (NE,77;SE,46,49)

- Understands ways in which the carrying capacity of a particular region depends upon many interrelated factors (availability of natural resources, climate characteristics, topographic features, population density)

BD (NE,78;SE,27,49)

- Understands the role of technology in interactions between human and physical systems (effects of strip mining on access to subterranean resources, soil erosion, water contamination, and habitat destruction; effects of increased carbons in the atmosphere and acid precipitation; chlorofluorocarbons and the depletion of the ozone layer)

BD (NE,77-79;SE,45-46)

- Understands how the cumulative effects of the outputs of human systems can impinge on physical systems (chain of events that link population growth, economic activities, air pollution, acid rain, and the destruction of forested areas)

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BD (NE,77;SE,33,46,49)

- Understands how the effects of human activities on the environment can be reduced (e.g., setting aside public lands, establishing animal preserves and bird sanctuaries, penalizing those who pump effluents into bodies of water)

(NI,80)

16. Understands the changing meaning and importance of resources

Level I

BD (GI,15;NI,51;SE,50;TI,13)

- Knows the role that resources play in our daily lives (resources used to generate electricity; resources used to produce automobiles, jewelry, clothing, books, medicines, wooden pencils)

Level II

BD (GI,15;NI,50;SE,50;TI,41)

- Knows types of energy used in different parts of the world and reasons for the differences

BD (GI,15;NE,50;SE,50;TI,37;DI,7.3.2)

- Knows the location and use of renewable, flow, and non-renewable resources

BD (GE,17;NI,50;SE,50,53;TE,36)

- Knows the relationship between the location of resources and the distribution of population (relationship of major industrial districts to the location of iron ore and coal; relationship of transportation routes and carrier modes to the location of resources; human migration as a result of the depletion of a resource)

BD (GI,14;NE,44;SE,50;TI,37-38)

- Knows how technology has changed the way we locate and use resources (enables oil companies to find oil underwater on the continental shelf, enables recycling of materials, enables commercial fishermen to locate schools of fish)

BD (GI,14;NE,43;SE,51;TI,37)

- Knows advantages and disadvantages related to the use of various natural resources (recycling and reusing materials; damming a river; generating nuclear power)

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BD (GI,16;NI,48;SE,53-54;TI,42)

- Knows historic and current conflicts and competition regarding the use and allocation of resources (aboriginal Americans and farmers in the Great Plains, slave trade within and outside the continent of Africa, the competition between farmers and urban dwellers for use of the land on the edge of cities)

Level III

BD (NI,49-50,66;SE,51,53)

- Knows the role resources have played in opening new territories and changing settlement patterns (the California Gold Rush, creation of ghost towns in the American West; the fur trade that lured the French and British to the American Northwest; the early development of Pittsburgh, Pennsylvania; the Soviet expansion into Siberia)

BD (NI,61;SE,51-52)

- Knows strategies for wise management and use of renewable, flow, and non-renewable resources (wise management of agricultural soils, fossil fuels, and alternative energy sources; community programs for recycling or reusing materials)

BD (NE,62;SE,51)

- Knows the advantages and disadvantages of various forms of energy development (hydroelectricity, nuclear energy, fossil fuels, alternative energy sources)

BD (NI,61-62;SE,51)

- Understands how major events and national attention affect the use and misuse of resources (the book *Silent Spring* by Rachel Carson; the annual Earth Day celebration; major oil spills such as the Exxon Valdez; nuclear accidents such as Chernobyl and Three Mile Island; battle between Love Canal and the Hooker Chemical Company over the disposal of toxic wastes)

BD (NE,67;SE,52)

- Understands reasons for conflicting viewpoints regarding how resources should be used (attitudes regarding how resources have improved quality of life; attitudes regarding species extinction; attitudes regarding environmental outcomes of extracting and using resources; attitudes regarding the position, "the greatest good for the greatest number of people")

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Level IV

BD (NI,75;SE,52)

- Knows ways in which the search for resources has led to exploration, settlement, and colonization (motivations for early Spanish and Portuguese expansion in the New World; European interests in the late 19th century penetration and colonization of Africa; motivations for Dutch and Portuguese voyages to Asia; motivation for Soviet expansion eastward after 1928)

BD (NI,88;SE,52)

- Understands the consequences of the development, use, and misuse of various forms of energy and resources (implications of wealthy nations consuming large amounts of resources, such as the U.S., where 6% of the world's population consumes more than one third of the world's resources; issues surrounding the consumption of Middle Eastern oil; resource degradation and depletion in developing countries)

BD (NI,80;SE,52)

- Understands national, state, and local programs and positions related to use of resources (selling and leasing government land to lumber interests; positive and negative consequences of the Clean Air and Water Act; performance of past and present U.S. political administrations; local recycling programs; environmental impact statements and resource-management proposals)

BD (NI,81;SE,58)

- Understands the relationship between resource use and equity (for future generations, and for the world's present population where access to natural and social resources is unequal)

BD (NE,88;SE,34)

- Understands how the unequal distribution of the world's resources contributes to patterns of trade, settlement, and warfare

17. Understands how geography is used to interpret the past

Level I

BD (GE,14;NE,38;SE,53;TE,16,20)

- Knows how areas of a community have changed over time

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Level II

BD (GI,14;NI,46;SE,53;TE,21)

- Knows geographical factors that have influenced where people live (early migrants to the United States and other places were attracted to geographical characteristics similar to their places of origin when they selected a place to live; pathways such as the Hudson and Mississippi River valleys and the Great Lakes led to early settlement in some areas)

BD (GI,14;NI,40;SE,53;TI,39)

- Knows how some physical features (mountains, oceans) were barriers to historical movement in the United States while others (rivers, valleys, mountain passes) were pathways

BD (GI,16;NI,48;SE,53;TI,39-40)

- Knows geographical backgrounds of various kinds of boundaries and how they have affected historical and current conflicts (the United States-Mexican border along the Rio Grande)

Level III

BD (NI,64;SE,54)

- Knows geographical concepts relating to the opening of territory and settlement patterns in the United States (Manifest Destiny, frontier, wilderness, metes and bounds, township land survey, long lots, "staking a claim")

BD (NI,64;SE,54)

- Understands the territorial evolution of the United States (extent of the original thirteen colonies and territories, areas added to the United States until the present-day boundaries were achieved; outcomes of territorial acquisitions such as the Louisiana Purchase and the Treaty of Guadeloupe Hidalgo)

BD (NI,68-69;SE,54)

- Knows the role of great explorers and mappers in opening new territories in the United States (Zebulon Pike, John Wesley Powell, the Lewis and Clark expedition)

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BD (NE,57;SE,54;DI,12.3.2)

- Understands physical and cultural factors that have affected the location, size, and importance of urban areas over time (natural harbors; mineral deposits; the confluence of rivers, landforms, soils; railroads; interstate highways; agricultural zones)

BD (NE,64;SE,54;DI,12.4.5)

- Understands how ethnic sections have developed and changed in major American cities and rural America (development of Little Italy, Greektown, Chinatown; African American migration from the rural South to the urban North; persistence of low-income ethnic neighborhoods)

BD (NI,68-69;SE,54,55)

- Knows how geographical factors have influenced major historic events and movements (final outcomes of battles and wars; major waves of immigration such as the westward movement in the United States, the eastward movement in Russia, and the forced migration of Africans to this country; routes of various expeditions throughout the world)

Level IV

BD (NI,75;SE,55)

- Understands the motivations and geographical, cultural, and environmental factors that influenced territorial evolution of major nations of the world (alternating expansion and shrinking of the Chinese empire, the development of Australia)

BD (NE,87;SE,55;DE,9.2.3)

- Understands geographical factors related to large-scale migrations (the "boat people" of southeast Asia; illegal Mexican migrants; starvation in the Sahel and the resultant creation of vast numbers of refugees; effects of migration on the growth of urban areas)

BD (NI,79,82,85;SE,55)

- Knows key transportation channels and their geographic importance through history (the importance of the Suez Canal to the economies of shipping Middle Eastern oil; the importance of the Sunda Straits to world shipping; the importance of the English Channel as a transportation route and as a barrier; the location of the Panama Canal)

BD (NI,85;SE,55)

- Understands geographic factors that have affected major historical outcomes (the origin and diffusion of the agricultural, industrial, and telecommunications revolutions; role and

effects of various explorations and expeditions on the course of world history; factors that shaped the courses and outcomes of major military operations in history)

(NI,75)

18. Understands global development and environmental issues

Level II

BD (GE,16;NI,51;SE,56;TE,44)

- Knows characteristics and locations of nations in the developing and developed worlds

BD (GI,15;NI,43;SE,56;TI,42)

- Knows ecological/technological trade-offs that are taking place in selected areas of the world (changing weather patterns and increased soil salinization in the Nile Valley due to the Aswan Dam)

BD (GI,16;NI,43;SE,56;TI,30)

- Understands the concept of sustainable development (nature and use of renewable and non-renewable resources; methods of managing resources such as crop rotation, recycling, water conservation measures)

Level III

BD (NI,56;SE,57)

- Knows the strengths and weaknesses of terms used to classify uneven development in different regions (developed, developing, underdeveloped; rich and poor; industrialized and non-industrialized; commercial economy and subsistence economy; modern and traditional; First, Second, Third, Fourth Worlds; theory of demographic transition)

BD (NI,70;SE,57)

- Knows ways in which development can be measured (gross national product, literacy rate, employment trends)

BD (NI,61;SE,57)

- Understands the term sustainable environment and how it is related to environmental and resource management (human attempts to limit stress on ecosystems such as local ordinances that establish criteria for strip-mall development, privately funded planning grants to study the location of an international airport, crop rotation, preservation of open space, maintaining constant stocks of renewable resources)

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BD (NE,60;SE,57)

- Knows ways in which local behavior can affect other parts of the world over time

Level IV

BD (NE,75;SE,57;DE,12.4.3)

- Knows the patterns of global development (the characteristics and location of the world's more developed regions versus those of less-developed regions)

BD (NI,77;SE,57)

- Knows the positive and negative aspects of development in selected regions of the world (the timber industry in Malaysia results in an improved economy but significant deforestation)

BD (NE,74;SE,57)

- Knows the weaknesses of common indicators used to describe development of world regions (national data that masks regional differences within a country, averages that ignore differences related to gender, age, social class, or wealth)

BD (NI,79-80;SE,58)

- Understands the concept of sustainable development, its interacting dimensions (environmental, economic, human, and technological), and how it relates to the world's present and future needs (policies concerning equity for future generations, and for the world's present population where access to natural and social resources is unequal)

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11. Communication and Information Processing

The following process was used to identify the standards and benchmarks in this category.

Identification of National Reports
This category of standards deals with the comprehension, understanding and representation of information gained from print and other media. It also deals with the communication of information in a variety of media, but with an emphasis on writing. This category not only involves many of the skills and abilities associated with the English language arts, such as basic reading and writing competencies, but it includes reading, writing and information gathering associated with the workplace.

Given the breadth of this category, reports from two distinct domains were identified as relevant. Selected from the domain of the English language arts was the draft document of the Standards Project for English Language Arts entitled Incomplete Work of the Task Forces of the Standards Project for English Language Arts (1992). The document is the product of a joint effort of the Center for the Study of Reading (CSR) at the University of Illinois, the International Reading Association (IRA) and the National Council of Teachers of English (NCTE). Identified from the domains of the workplace were the documents: What Work Requires of Schools: A SCANS Report for America 2000 (The Secretary's Commission on Achieving Necessary Skills, 1991) and Workplace Basics: The Essential Skills Employers Want (Carnevale, Gainer & Meltzer, 1990). Both documents focus on what might be termed as workplace literacy and both place heavy emphasis on communication and information processing skills and abilities. Finally, statements from the National Council of Teachers of Mathematics Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989), were considered; particularly those that dealt with the standard, mathematics as communication.

Selection of Reference Document and Identification of Standards and Benchmarks
The reference document selected for this category was the draft document of the Standards Project for English Language Arts. It was selected because it is, in effect, considered the "official" effort to identify standards in the English language arts due to its affiliation with CSR, IRA and NCTE and its funding from the U.S. Department of Education. However, the document presented some serious problems for this study. Specifically, in this study we have chosen to articulate standards as groups of related declarative, procedural and contextual knowledge. This approach, by definition, is fairly specific and, as could be inferred from the discussion in Section 3, runs the risk of being too reductive. The language arts draft document has taken an approach that might be considered the other extreme.

The document identifies explicit standards in five broad areas referred to as strands. The five strands are: 1) Reading/Literature, 2) Writing, 3) Language, 4) Real World Literacy, and 5) Interconnections. Standards are then identified within each strand, although some strands identify a single standard only. Identification of categories (strands) and explicit standards

within those categories is, of course, compatible with the structure of this study. However, this is where the similarities end.

Rather than identify what students should know and be able to do in specific terms within each standard, the document authors have chosen to provide vignettes at one or more of three levels: early school, middle school and high school. In simple terms, a vignette is a description of what might occur in a classroom that exemplifies a specific standard. At the end of each vignette is a list of student "accomplishments" exemplified in the vignette. For example, the following are the accomplishments listed for the early school vignette for the Reading/ Literature Standard, "Students will read, discuss and write about literature so that they can learn about themselves and their values, assumptions and beliefs":

* see their lives reflected in literature
* clarify assumptions about others as they read
* respect the uniqueness and diversity of individuals
* relate literature to their own lives

Some of the accomplishments listed after the various vignettes approached explicit statements of knowledge and skill.

Given the very specific nature of standards and their related benchmarks as defined in this study, we analyzed the vignettes, and the list of accomplishments following each vignette, for implied and (occasionally) explicit statement of declarative, procedural and contextual knowledge. In effect, we were obliged to extract implied statements of declarative, procedural and contextual knowledge based on a close reading of the activities and dialogues described in the vignettes.

Another problem we encountered with the document was that vignettes were not provided for all levels for all standards. That is, some standards did not have vignettes for the early school, middle school or high school levels. In such cases, we inferred whether the declarative, procedural or contextual knowledge was intended for all levels or for a specific level only.

Integration of Information From Other Documents

Within the SCANS report and Workplace Basics, communication and information processing skills and abilities are described in very specific statements of declarative, procedural and contextual knowledge. However, this knowledge is not identified by levels. Rather, both documents state that the skills and abilities they describe should be learned by the time a student graduates. Consequently, statements taken from the SCANS report and Workplace Basics were generally given a level 4 designation.

Finally, statements for the NCTM's Curriculum and Evaluation Standards for School Mathematics proved very compatible with this study, since benchmark information in that report is reported in levels and in very specific terms.

(SI,xviii;WI,90,106-107)

1. Gathers information effectively through reading, listening and viewing

Level I

BC (EI,34-37,54;SI,xviii;WI,90,106-107)

- Provides an accurate retelling of the basic plot of simple stories they have read, heard or viewed

BC (EI,34-37,54;SI,xviii;WI,90,106-107)

- Provides an accurate retelling of the main idea of simple expository information they have read, heard or viewed

BD (EI,62;SI,xviii;WI,90,106-107)

- Understands that reading, viewing and listening are ways of gaining information about the world

BP (SI,xviii;WI,90-91,106-107)

- Determines meaning of simple words from context

BP (SI,xviii;WI,90,106-107)

- Creates mental representations for concrete information read, heard or viewed

Level II

BC (EI,34-37,54;SI,xviii;WI,90,106-107)

- Provides an accurate summary of basic plot of complex stories they have read, heard or viewed

BC (EI,34-37,54;SI,xviii;WI,90,106-107)

- Provides an accurate summary of the main themes of complex expository information they have read, heard or observed

BP (SI,xviii;WI,90-91;106-107)

- Determines meaning of complex words from context

BP (EI,54;SI,xviii;WI,90,106-107)

- Makes and confirms simple predictions about what will be found in a text

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BP (WI,90-91,106-107;SI,xvii;MI,81)

- Creates mental representations for abstract information read, heard or viewed

Level III

BP (EI,17-21;SI,xviii;WI,90,106-107)

- Determines how realistic elements of a text are

BD (MI,78;SI,xviii;WI,90,106-107)

- Understands written information containing mathematics concepts

BD (MI,78;SI,xviii;WI,90,106-107)

- Understands abstract concepts presented visually

BP (EI,54;SI,xviii;WI,90,106-107)

- Makes and confirms/disconfirms complex predictions about what will be found in a text

BP (EI,54;SI,xviii;WI,90,106-107)

- Generates interesting questions to be answered while reading, listening, observing

BP (EI,25;SI,xviii;WI,90,106-107)

- Identifies those situations in which they are confused while reading, listening, observing

BP (EI,54;SI,xviii;WI,90,106-107)

- Reflects on what has been learned after reading, listening, observing

BP (EE,58;SI,xviii;WI,90,106-107)

- Organizes prior knowledge of a topic before reading, listening or viewing

BC (EI,58;SI,xviii;WI,90,106-107)

- Seeks peer help to understand information

BP (EE,56;SI,xviii;WI,90,106-107)

- Independently identifies explicit purpose for reading, listening or viewing

BD (EE,56;SI,xviii;WI,90,106-107)

- Identifies information organizing strategies that are personally most useful

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BP (EI,45;SI,xviii;WI,90,106-107)

- Gathers and synthesizes data from interviews

BP (EI,32,45;SI,xviii;WI,90,106-107)

- Gathers information using note taking

Level IV

BP (SE,xviii;WI,90,106-107)

- Synthesizes a variety of types of visual information including: pictures, symbols

BP (SI,xviii;WE,90)

- Effectively uses indices, appendices, glossaries and table of contents

BP (SI,xviii;WE,90)

- Determines figurative, idiomatic and technical meanings of terms through context

BP (SI,xviii;WE,90)

- Determines meaning of abbreviations and acronyms from context

BP (SI,xviii;WE,64,90)

- Uses cross referencing while gathering information

BP (SI,xviii;WE,90-91)

- Scans passage to determine whether a text contains relevant information

BP (SI,xviii;WE,90)

- Determines meaning of codes and symbols from context

BD (MI,140;SI,xviii;WI,90,106-107)

- Understands mathematical notation presented in writing

BD (EI,31;SI,xviii;WI,90,106-107)

- Understands that reading, viewing and listening are gradual processes of constructing meaning and makes revisions of initial understandings

BP (EE,32;SI,xviii;WI,90,106-107)

- Uses questions as a way of understanding a text

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BP (EI,32;SI,xviii;WI,90,106-107)

- Uses discussions with peers as a way of understanding information

BP (2E,246;SI,xviii;WI,64)

- Accurately illustrates information that others have presented

BP (SI,xviii;WE,106)

- Writes basic description of events to record information

BP (SI,xviii;WE,106)

- Summarizes dialogues for the purpose of collecting information

BP (SI,xviii;WE,106-17;EI,53)

- Represents key ideas and supporting detail in outline form

BC (SI,xviii;WE,106-107)

- Appraises a written communication for its clarity

2. Reads and responds to literature

Level I

BD (EI,61)

- Understands that stories have beginning, middle and ending episodes

BD (EI,34)

- Understands the genre of tall tales and fables

Level II

BP (EI,14-17)

- Makes connections between specific episodes in their own lives and specific elements of a literary text

BP (EI,14-17)

- Uses specific aspects of a piece of literature to better understand the actions of others in their life

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BD (EI,62)

- Understands the complexity of the various component parts of stories and their interconnections

BC (EI,26)

- Shares responses to literature with peers

Level III

BP (EI,17-21)

- Recognizes when a particular part of a literary text impacts them personally

BP (EI,17-21;EE,26)

- Selects an effective mode to communicate personal reaction to a piece of literature (e.g., a skit, a poem, role play)

BD (EE,17-21)

- Understands that people respond differently to literature

BP (EI,24)

- Identifies specific questions of personal importance and seeks to answer them through literature

BP (EE,26)

- Identifies specific interests and the literature that will satisfy those interests

Level IV

BP (EI,27)

- Relates personal response to the text with that intended by the author

BP (EI,30)

- Recognizes when and why they are responding to the text

BD (EI,30)

- Understands that reactions to a text will change throughout the text

BP (EI,31)

- Traces the origins of own responses to literature

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BC (EI,31)

- Voluntarily shares responses to texts with peers

BD (EE,32)

- Understands that a single text will elicit a wide variety of responses each of which is valid from a personal, subjective perspective

BD (EE,32)

- Understands that readers have the right and even the responsibility to bring their own values to bear as they respond to a text

(SE,xviii;WI,90)

3. Gathers information from technical documents, graphs, charts and tables

Level IV

BP (SE,xviii;WE,90)

- Accurately interprets information from a data matrix

BP (SE,xviii;WE,90)

- Detects inconsistencies in a data matrix

BP (SE,xviii;WE,90)

- Identifies main theme and supporting detail in technical documents

BP (SE,xviii;WI,90-91)

- Distinguishes between relevant and irrelevant information in technical documents

BP (SE,xviii;WE,90-91)

- Follows basic linear paths in organizational charts

BP (SE,xviii;WE,90-91)

- Scans completed forms to identify specific information

BP (SE,xviii;WE,90)

- Identifies major sections in schematic diagrams

BD (SE,xviii;WE,90)

- Identifies parts from a key or legend

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BP (SE,xviii;WE,90-91)

- Uses the linear path of a flow chart to provide visual and textual directions to a procedure

BP (SE,xviii;WE,90-91)

- Isolates a problem component in a schematic diagram and traces it to the cause of the problem

BP (SE,xviii;WE,90-91)

- Interprets symbols in a flow chart to indicate flow of direction, text points, components and diagrammatic decision points

BP (SE,xviii;WE,90-91)

- Identifies details, labels, numbers and parts from technical illustrations and pictures

BP (SE,xviii;WE,90-91)

- Interprets a drawing of a cross section for assembly or disassembly

BP (SE,xviii;WE,90-91)

- Obtains a factor specification from a two-column chart to find information

BP (SE,xviii;WE,90-91)

- Obtains a factor specification from an intersection of row by column in a table or chart

BP (SE,xviii;WE,90-91)

- Uses tables and charts to identify malfunctions

(WE,106)

4. Communicates ideas and information in writing

Level I

BD (EI,61;WE,106)

- Understands basic connection between spelling patterns and speech sounds

BD (EI,61;WE,106)

- Understands basic phonological patterns in English

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BP (EI,21,35;WE,106)

- Expresses ideas in simple expository forms

BP (EI,23,35;WE,106)

- Composes simple stories that express cohesive ideas

BP (EE,37;WE,106)

- Experiments with different genre as modes for expressing ideas

Level II

BP (EI,33;WE,106)

- Makes observation regarding strengths and weaknesses of own writing

BP (EI,34;WE,106)

- Revises compositions for internal logic

BP (EI,33;WE,106)

- Uses a variety of methods to plan and design compositions including discussions with peers, dramatization, graph representations and pictures

BP (EI,38;WE,106)

- Identifies topic, audience, purpose and genre for composition

BP (EI,67;WE,106)

- Composes comprehensive and detailed stories

BP (EI,65;WI,106)

- Uses writing to help accomplish real world tasks

BP (EE,66;WE,106)

- Effectively attends to standard conventions of grammar, punctuation and spelling when writing for formal audiences

BP (EI,66;WE,106)

- Uses notes and letters to communicate ideas, feelings and information

BP (EE,67;WE,106)

- Writes legibly

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BC (EE,67;WE,106)

- Seeks help from others to improve writing

BD (EE,67;WE,106)

- Understands the importance of editing

BP (EI,44;WE,106)

- Composes effective informational essays that require gathering information

BD (EI,37;WE,106)

- Identifies personal strengths, weaknesses and preferences regarding writing in different genre

Level III

BP (EE,21-23;WE,106)

- Identifies specific stylistic and rhetorical characteristics of "good" literature and utilizes them in own writing (e.g., descriptive phrases, use of foreshadowing)

BP (EI,38;WE,106)

- Writes for a variety of audiences including self, well-known others and broader reading public

BP (MI,78,140,150;WI,106-107)

- Uses technical terms and notation in writing

BP (EE,21-23;WE,106)

- Uses specific pieces of literature as vehicles for future writing topic development

BP (EI,39;WE,106)

- Uses direct feedback from peers to revise content of a composition

BP (EI,39;WE,106)

- Makes informed decisions about which works to place in portfolio representing various aspects of composing ability

BP (EI,45;WE,106)

- Constructs oral histories

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- Expresses complex information in narrative form — BP (EI,49;WE,106)

Level IV

- Enters information into basic forms correctly — BP (WE,106)
- Evaluates a written communication for it's clarity — BP (WE,106)
- Writes technical reports — BP (WE,106)
- Expresses ideas about mathematics in writing — BP (ME,140;WE,106)
- Uses personal response to text as a basis for writing — BP (EE,32;WE,106)
- Writes effectively for highly public audiences — BP (EE,50;WE,106)

5. Understands and applies basic principles of language use

Level I

- Recognizes characteristic sounds and rhythms of language — BD (EI,58)
- Makes valid observations about the use of words — BC (EI,58)
- Makes valid observations about the use of language at home as opposed to the use of language in school — BC (EI,60)

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Level II

- Identifies specific ways in which language varies across situations in their personal lives — BD (EI,42)
- Identifies the social context of conversations and its effect on the language used in conversations — BD (EI,43)
- Identifies the use of nonverbal cues used in conversation — BD (EI,43)
- Makes observations about language in real life situations — BC (EI,43)
- Identifies appropriate and inappropriate uses of language in different settings including school and home — BD (EI,44)
- Compares the ways in which language is used in a variety of contexts — BC (EI,44)
- Makes observations about specific uses of own language — BC (EI,45)
- Compares the uses of language in the home, community and school — BC (EI,45)

Level III

- Forms explicit conclusions regarding language use based on observation — BP (EI,49)
- Understands those factors that commonly affect the use of language — BD (EE,49)
- Communicates effectively in more than one language or dialect — BP (EI,49)

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Level IV

- Understands the influence of gender on language use — BD (EI,50)
- Carries out investigations of unanswered questions regarding language — BC (EI,50)
- Engages in public speaking around issues of personal concern — BP (EI,64)
- Understands the affect of specific aspects of culture on language use — BD (EI,50)
- Compares form, meaning and value of different kinds of language — BC (EE,51)
- Understands the political implications of using different forms of language — BD (EI,52)

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12. Thinking and Reasoning

The following process was used to identify the standards and benchmarks in this category.

Identification of Target Reports
No single document was used as the reference report for the standards and benchmarks in the standards category, thinking and reasoning. Rather, those statements which were judged to articulate thinking and reasoning processes that can be applied across content areas were extracted from the various documents reviewed. Ultimately, the standards and benchmarks in this category will be drawn from all documents used in this study. However, to date, only the following documents have been used to construct the standards and benchmarks in the thinking and reasoning category.

* Incomplete Work of the Task Force of the Standards Project for English Language Arts (Standards Project for the English Language Arts, 1992).
* Benchmarks for Science Literacy (Project 2061, 1992).
* What Work Requires of Schools: A SCANS Report for America 2000 (The Secretary's Commission on Achieving Necessary Skills, 1991).
* Workplace Basics: The Essential Skills Employers Want (Carnevale, Gainer & Meltzer, 1990).
* Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989).
* Mathematics Assessment Framework (NAEP, 1992).
* Historical Literacy (Bradley Commission on History in the Schools, 1990).
* Lessons from History: Essential Understandings and Historical Perspectives That Students Should Acquire (Crabtree, 1992)

Identification of Standards and Benchmarks From Target Reports
Explicit statements of thinking and reasoning were identified in all target reports. To illustrate, consider the following statements from NCTM's Curriculum and Evaluation Standards for School Mathematics (1989) :

* make and test conjectures
* formulate counter examples
* follow logical arguments
* judge the validity of arguments
* construct simple valid arguments

Each of these statements represents a reasoning process or subprocesses that could be used in a variety of subject areas. For example, one could judge the validity of arguments or construct simple valid arguments in mathematics, in science or in history. Statements such as these found in any document were extracted and used as the statement base from which the thinking and reasoning standards were constructed.

In addition to explicit statements of general reasoning processes like those above, implicit statements of general thinking and reasoning processes were also identified and the thinking and reasoning process made explicit. For example, the NCTM document contains the following statement:

* formulate problems from everyday and mathematical situations (p.23)

Implicit in this statement is the thinking and reasoning process of formulating problems within a variety of situations.

In summary, both implicit and explicit statements of general thinking and reasoning processes were used to construct the standards within the thinking and reasoning category. It is again important to emphasize the fact that our listing of general thinking and reasoning processes is not meant to imply that thinking and reasoning can or should be addressed in isolation of domain specific content. However, providing a listing of generalized processes allows a school or district to distribute thinking and reasoning systematically throughout the various content domains. Additionally, it is our hope that a listing such as ours will help schools and districts break the perceptual set regarding many thinking and reasoning processes. For example, it is usually assumed that problem solving should be assigned exclusively to the domain of mathematics and hypothesis testing exclusively to the domain of science. However, if one carefully examines the standard in this section entitled "generates and solves general problems," he will find that it is applicable to many domains as is the standard "understands and applies basic principles of hypothesis testing and scientific investigation."

(WI,64)

1. Understands and applies basic principles of presenting an argument

Level I

BD (2E,160;WI,64)

- Understands that people are more likely to believe ideas if good reasons are given for them

BP (2E,160;WI,64)

- Provides coherent (though not necessarily valid or convincing) answers when asked why they believe something to be true

BP (2I,249;WI,64)

- Makes a rough determination as to the strengths or weaknesses of a simple argument

BP (2E,249;WI,64)

- Asks "how do you know" in appropriate situations

BP (2E,249;WI,64)

- Makes basic determinations regarding which information to pay attention to and which information to ignore in simple arguments

Level II

BC (2E,250;WI,64)

- Seeks out information to support an argument

BP (2E,250;WI,64)

- Identifies basic informal fallacies including: use of statements such as "everybody knows;" appeals to authority; vague references such as "leading doctors say"

BD (2E,194;WI,64)

- Understands that reasoning can be distorted by strong feelings

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2 = Project 2061: Benchmarks for Science Literacy
B = Bradley Commission on History in the Schools
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L = Lessons from History
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Level III

BP (2E,250;WI,64)

- Identifies basic informal fallacies including: intermingling of fact and opinion; lack of explicit premises; overgeneralizing

BP (2E,195;WI,64)

- Identifies exceptions to proposed generalizations

BP (MI,78;ME,105;WI,64)

- Evaluates arguments that are based on quantitative data and mathematical concepts

BD (2E,194;WI,64)

- Understands that some types of reasoning involve the application of specific rules whereas others do not: those types that do are commonly used to provide evidence for claims or to prove things; other types, such as reasoning by similarity, are not used to provide evidence or to prove things

Level IV

BD (2E,195;WI,64)

- Understands the basic distinction between necessary and sufficient reasons

BD (2E,195;WI,64)

- Understands that there are certain situations in which reasoning may not be effective or useful

BD (2E,195;WI,64)

- Understands the general nature of confirmatory bias

BP (2E,196;WI,64)

- Describes the reasoning in arguments in terms of premises and conclusions and analogies and identifies errors in logic or form

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BD (2I,251;WI,64)

- Understands that support for a claim should include a variety of types of evidence including logical and quantitative

BP (2I,252;WI,64)

- Identifies techniques used to slant information in subtle ways

BC (MI,143;WI,64)

- Identifies the logic of arguments that are based on quantitative data

(BI,25;EI,50-52;LI,41;WI,90)

2. Effectively utilizes mental processes that are based on identifying similarities and differences

Level I

BC (EI,50-52;WE,90)

- Classifies objects by size, color or other significant characteristics

BC (EI,50-52;MI,32,60;WI,90)

- Identifies similarities and differences between simple concepts and concrete persons, places, things and events

Level II

BD (2E,194;EI,50-52;WI,90)

- Understands that identifying how something unfamiliar is similar to something familiar makes the unfamiliar thing more understandable

BP (2E,194;EI,50-52;WI,90)

- Understands and creates analogies used to clarify new information

BC (EI,50-52;MI,32,60;WI,90)

- Identifies similarities and differences between abstract concepts

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Level III

BC (2E,195;EI,50-52;WI,90)

- Critiques analogies regarding the accuracy of identified likenesses and on ways that they neglect differences

BP (2E,245;EI,50-52;WI,90)

- Identifies patterns based on repetition of elements in a variety of situations

Level IV

BP (EI,50-52;WI,90,202)

- Forms categories based on discovered rules

BP (EI,50-52;ME,146;WI,90)

- Recognizes equivalent representations of abstract concepts in a variety of academic and real world situations

3. Understands and applies basic principles of logic

Level II

BP (2E,194)

- Makes valid "if...then" statements

Level III

BD (2E,194)

- Understands basic meaning of logical connectors: "if...then," "not," "and," "or"

BP (2E,195)

- Evaluates the conclusions of simple logical arguments involving connectors: "if...then;" "not," "and," "or"

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BP (NI,34;MI,81)

- Uses formal deductive connectors ("if...then," "not," "and," "or") in the construction of deductive arguments

Level IV

BD (2I,246)

- Understands the differences between the formal and informal uses (in everyday situations) of the logical connectors: "if...then," "not," "and," "or"

BP (ME,143)

- Constructs mathematical proofs

BP (ME,143)

- Constructs indirect proofs

BP (ME,143)

- Uses mathematical induction

BD (2E,196)

- Understands that formal logic may be of limited help in finding solutions to problems if we aren't sure that general rules hold or that particular information is correct; most often, we have to deal with probability rather than certainty

(BI,25;LI,41;WI,64)

4. Understands and applies basic principles for forming generalizations and making inductions

Level I

BP (WE,90-91)

- Makes appropriate default inferences regarding familiar persons, places, things and events

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Level II

BP (EI,43;WI,64)

- Makes inferences regarding the intentions underlying people's comments

Level III

BD (2E,195;WI,64)

- Understands that there are a variety of ways people can form generalizations including: basing them on many observations; basing them on very few observations and constructing them on only one or two observations AND can describe the implications of each method

BP (NE,39;WI,64)

- Makes predictions about the future based on reasoned premises

BP (MI,78,81,143;NI,34;WI,64)

- Makes and validates conjectures about outcomes of specific alternatives or events

BP (ME,105;WI,64)

- Makes inferences based on quantitative information (e.g., graphs and tables)

BP (ME,78,143;WI,64)

- Develops definition of abstract concepts based on observations

Level IV

BP (SI,xviii;WI,64)

- Generates a rule explaining a correlational relationship between two or more variables

BP (ME,143;WI,64)

- Identifies counter examples to conclusions that have been developed

BD (EI,50;WI,64)

- Is aware of stereotypes in common inferences about persons, places, things and events

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(WI,64)

5. Understands and applies basic principles of hypothesis testing and scientific investigation

Level I

BP (2E,196;WI,64)

- Asks "how do you know" when provided with unusual explanations

BP (2E,196;WI,64)

- Asks "what will happen if" when presented with interesting situations

Level II

BP (2E,240;WI,64)

- Recognizes basic patterns in nature and provides explanations for them

BP (2E,240;WI,64)

- Generates alternative explanations to explain phenomena

BP (2E,246;WI,64)

- Documents basic observations using notes or notebook and distinguishes between true observations as opposed to conclusions about observations

BP (MI,23,36,75;NI,27;WI,64)

- Attempts to verify results of experiments

Level III

BP (2E,240;WI,64)

- Judges the adequacy of alternative explanations by identifying the type of evidence necessary to support each alternative

BP (MI,75;NI,27;WI,64)

- Accurately and effectively verifies results of experiments

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Level IV

BD (2E,196;WI,64)

- Understands that proving that a hypothesis is false (just one exception will do) is much easier than proving a hypothesis is true (for all possible cases)

BD (2E,241;WI,64)

- Understands that the same scientific principles should apply in a variety of situations

BD (2E,241;WI,64)

- Understands that a discrepancy between theory and observation may result from inadequate theories or inaccurate observations

BD (2E,241;WI,64)

- Understands that what people study and how they study it depends on their theories

BP (2I,241;WI,64)

- Demonstrates a healthy skepticism regarding their own explanations by presenting evidence for explanations other than their own

BP (ME,167;WI,64)

- Tests hypotheses statistically

BP (2E,252;WI,64)

- Revises studies to improve their validity in terms of better sampling, better controls or better data analysis techniques

(BI,25;LI,41;EI,63;WE,182;WI,64)

6. Generates and solves general problems

Level IV

BP (EI,63;SI,xviii;WE,182;WI,64)

- Engages in effective problem finding and framing

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BP (EI,63;MI,23;WE,182;WI,64)

- Represents problem accurately in terms of resources, constraints and objectives

BP (EI,63;WE,182;WI,64)

- Provides summative evaluation of effectiveness of problem solving techniques

BP (EI,63;WE,182,202;WI,64)

- Reframes problems when alternative solutions are exhausted

BP (EI,63;WE,329;WI,64)

- Accurately identifies the most critical obstacle or constraint in a problem

BD (BI,25;LI,41)

- Understands that a problem might not have a solution given the current manner in which it is framed

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13. Working with Others

The following process was used to identify the standards and benchmarks in this category.

Identification of National Reports and Reference Documents
The category of standards entitled "Working with others" deals with skills and abilities that are associated within groups and with those skills and abilities associated with effective interpersonal communications. Even though many of the national reports made mention of the need for students to work in cooperative environments and use interpersonal communication skills, only those from the domain of workplace literacy identified specific skills and abilities that should be demonstrated by students. Two documents from this domain were selected as the reference reports for this category: What Work Requires of Schools: A SCANS Report for America 2000 (The Secretary's Commission of Achieving Necessary Skills, 1991) and Workplace Basics: The Essential Skills Employers Want (Carnevale, Gainer & Meltzer, 1990). They were selected as co-reference documents because of their similar purpose and format. Workplace Basics places heavy emphasis on this category of standards although it does not explicitly identify a category referred to as working with others. Rather, it articulates related categories such as interpersonal skills, negotiation skills, teamwork and listening and oral communication skills. The SCANS report identifies working with others as one of the five general competencies important in the workplace. Within this category it lists such areas as: participates as a team member, teaches others new skills and exercises leadership.

Identification of Standards and Benchmarks
Both reports articulate skills and abilities at a level of generality highly compatible with the specific declarative, procedural and contextualized structures that serve as the foundation for the standards and benchmarks identified in this report.

One convention adopted by both reports was not compatible with this study. Specifically, neither report identifies the levels at which their articulated skills and abilities should be emphasized. The SCANS report simply notes that all identified skills and abilities should be reinforced at kindergarten through twelfth grade levels; Workplace Basics lists the skills and abilities it identifies as important for graduation. Rather than arbitrarily identify the levels at which the various skills and abilities should be emphasized, we adopted the convention of placing them all at Level 4. Thus a school or district wishing to adopt the skills and abilities in this section would have to devise a system to determine the benchmark levels for themselves.

(WE,307;WI,64)

1. Contributes to the overall effort of a group

Level IV

- Responsibly challenges practices in a group that are not working — BP (SE,xvii;WE,307;WI,64)
- Demonstrates respect for others in group — BP (SI,xviii;WE,307;WI,64)
- Identifies and utilizes the strengths of others — BP (WE,307;WI,64)
- Takes initiative when needed — BP (WE,307;WI,64)
- Identifies and deals with causes of conflict in a group — BP (WE,307;WI,64)
- Helps group establish goal — BP (WE,397;WI,64)
- Engages in active listening — BP (WE,307-308;WI,64)
- Takes the initiative in interacting with others — BP (WE,307-308;WI,64)
- Evaluates the overall progress of a group toward a goal — BP (WE,329;WI,64)
- Keeps requests simple — BP (WE,231;WI,64)

(WI,349)

2. Uses conflict resolution techniques

Level IV

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BP (SE,xvii;WI,349)

- Communicates ideas in a manner that does not irritate others

BP (SE,xvii;WI,349)

- Effectively resolves conflicts of interest

BD (WE,349)

- Identifies goals and values important to opponent

BD (WE,231;WI,349)

- Understands the impact of criticism on psychological state, emotional state, habitual behavior and beliefs

BD (WE,231;WI,349)

- Understands that three ineffective responses to criticism are: 1) being aggressive, 2) being passive and 3) being both

BD (WE,231;WI,349)

- Understands that three effective responses to criticism are: 1) acknowledgement, 2) token agreement with a critic, and 3) probing clarifications

BP (WE,329;WI,349)

- Determines the causes of conflicts

BP (WE,231;WI,349)

- Does not blame

BP (WE,329;WI,349)

- Identifies an explicit strategy to deal with conflict

BP (WE,349)

- Determines the seriousness of conflicts

BP (WE,231;WI,349)

- Identifies mutually agreeable times for important conversations with opponents

BP (WE,349)

- Identifies individual vs group or organizational interests in conflicts

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BP (WE,349)

- Establishes guidelines and rules for negotiating

BP (WE,349)

- Determines the mini-max position of those in a conflict

(WI,134-136,307-308)

3. Displays effective inter-personal communication skills

Level IV

BP (SI,xviii;WI,134-136,307-308)

- Displays empathy with others

BP (SI,xviii;WI,134-136,307-308)

- Displays friendliness with others

BC (SI,xviii;WI,134-136,307-308)

- Displays politeness with others

BP (WI,64;WI,134-136,307-308)

- Seeks information non-defensively

BP (WE,64;WI,134-136,307-308)

- Provides feedback in a constructive manner

BP (WI,134-136,151,307-308)

- Uses nonverbal communication effectively such as eye contact, body position, voice tone

BP (WI,134-136,151,307-308)

- Does not react to a speaker's inflammatory deliverance

BP (WE,151;WI,134-136,307-308)

- Identifies with speaker while maintaining objectivity

BP (WE,307;WI,134-136)

- Uses emotions appropriately in personal dialogues

BP (WE,307;WI,134-136)

- Makes use of confrontation when appropriate

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BP (WE,134-136;WI,307-308)

- Makes eye contact when speaking

BP (WE,151-154;WI,134-136,307-308)

- Reacts to ideas rather than the person presenting the ideas

BP (WE,134-136;WI,307-308)

- Adjusts tone and content of information to accommodate the likes of others

BP (WI,307-308;WI,134-136,307-308)

- Communicates in clear manner during conversations

BP (WE,307-308;WI,134-136,307-308)

- Acknowledges the strengths of others

(WE,397)

4. Demonstrates leadership skills

Level IV

BP (WE,397)

- Enlists others in working toward a shared vision

BP (WE,397)

- Plans small wins

BP (WE,397)

- Celebrates accomplishments

BP (WE,397)

- Recognizes contributions of others

BP (WE,397)

- Passes on authority when appropriate

(SE,xvii)

5. Works well with diverse individuals and in diverse situations

Level IV

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- Works well with the opposite gender — BP (SE,xvii)
- Works well with different ethnic groups — BP (SI,xvii)
- Works well with those of different religious orientation — BP (SI,xvii)
- Works to satisfy needs of customers — BP (SE,xvii)

14. Self-regulation

The following process was used to identify the standards and benchmarks in this category.

Identification of National Reports and Reference Documents

The self-regulation standards include skills and abilities that address executive and metacognitive functions such as setting and monitoring goals and maintaining a healthy sense of self. Because of their similar purpose and format, two documents were identified as co-reference reports for this category of standards: What Work Requires of Schools: A SCANS Report of America 2000 (The Secretary's Commission on Achieving Necessary Skills, 1991) and Workplace Basics: The Essential Skills Employers Want (Carnevale, Gainer & Meltzer, 1990). Although neither document contains a category referred to as self-regulation per se, both contain categories that are strongly related. For example, the SCANS report lists skills and abilities within the general areas of setting goals, managing resources, self esteem, and self management. Workplace Basics describes skills and abilities within categories such as self esteem, goal setting, motivation and learning to learn.

Identification of Standards and Benchmarks

Both documents report their skills and abilities at levels highly compatible with the format for benchmarks adopted in this study. That is, both documents presented statements that were easily translated into specific elements of declarative, procedural and contextual knowledge. Neither document, however, described the levels at which their identified skills and abilities should be emphasized. Rather, both allude to the fact that all skills and abilities should be acquired by students by the time they graduate. Rather than attempt to assign the declarative, procedural and contextual elements in this category to the various benchmark levels, all were assigned to level IV.

(WE,284-285)

1. Sets and manages goals

Level IV

BP (SI,xviii;WE,284-285)

- Sets explicit long-term goals

BP (SE,xvii;WI,284-285)

- Identifies and ranks relevant options in terms of accomplishing a goal

BP (SE,xvii;WI,284-285)

- Prepares and follows schedule for carrying out options

BD (WE,231,284-285)

- Understands personal wants versus needs

BP (WI,231;WE,284-285)

- Establishes milestones

BP (WI,231,241;WE,284-285)

- Identifies resources necessary to complete a goal

BP (WI,64;WE,284-285)

- Displays a sense of personal direction and purpose

BP (WI,241;WE,64,284-285)

- Maintains an awareness as to proximity to goal

BP (WE,182-184,284-285)

- Makes summative evaluation of goal

BD (WE,241,284-285)

- Understands the differences between different types of goals

BP (WE,241,284-285)

- Sets routine goals for improving daily life

BP (WE,241,284-285)

- Identifies explicit criteria for evaluating goals

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- Makes contingency plans — BP (WE,284-285)

2. Performs self appraisal — (SE,xviii;WI,231)

Level IV

- Distributes work according to perceived strengths — BP (SE,xviii;WI,231)
- Identifies personal styles — BD (SE,xviii;WI,64,231)
- Identifies strengths and weaknesses — BD (SE,xviii;WE,231)
- Utilizes techniques for overcoming weaknesses — BP (SE,xviii;WE,231)
- Identifies basic values — BD (SE,xviii;WE,231)
- Performs analysis of employability — BP (SE,xviii;WE,284-285;WI,231)
- Understands preferred working environments — BD (SE,xviii;WE,284;WI,231)
- Understands career goals — BD (SE,xviii;WE,284;WI,231)
- Identifies a strength for each weakness — BP (SE,xviii;WE,231)
- Develops an inventory of wants versus needs — BP (SE,xviii;WI,231)
- Determines explicit behaviors that are being taken and should be taken to obtain wants and/or needs — BD (SE,xviii;WE,231)

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- Identifies personal motivational patterns — BD (SE,xviii;WE,284-285;WI,231)
- Keeps a log documenting personal improvement — BP (SE,xviii;WE,231)
- Summarizes personal educational background — BP (SE,xviii;WE,284-285;WI,231)
- Summarizes personal work experience — BP (SE,xviii;WE,284-285;WI,231)
- Identifies key accomplishments and successes in life — BD (SE,xviii;WE,284-285;WI,231)
- Identifies peak experiences and significant life experiences — BD (SE,xviii;WE,284-285;WI,231)
- Identifies desired future accomplishments — BD (SE,xviii;WE,284-285;WI,231)
- Identifies preferred life style — BD (SE,xviii;WE,284-285;WI,231)

3. Considers risks

Level IV

- Weighs risks in making decisions and solving problems — BP (SI,xviii)
- Uses common knowledge to avoid hazard or injury — BP (WE,90-91)
- Applies preventative measures prior to a task to minimize security or safety problems — BP (WE,90-91)
- Selects appropriate course of action in an emergency — BP (WE,90-91)

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BP (WE,281-283)

- Identifies emergency and safety procedures before undertaking hazardous procedures

BP (WE,349)

- Thinks clearly under stress

4. Demonstrates perseverance

Level IV

BP (SE,xviii)

- Demonstrates perseverance relative to personal goals

BP (WI,64)

- Demonstrates sense of purpose

BP (WE,202)

- Maintains high level of energy over prolonged periods of time when engaged in tasks

BP (WE,202)

- Persists in the face of difficulty

BP (WE,151-154)

- Concentrates mental and physical energies

(WE,231)

5. Maintains a healthy self concept

Level IV

BD (SI,xviii)

- Has basic belief in ability to succeed

BP (WE,231)

- Uses techniques to remind self of strengths

BP (WE,231)

- Utilizes techniques to offset the negative effects of mistakes

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- Avoids overreacting to criticism — BP (WE,231)
- Uses affirmations to improve sense of self — BP (WE,231)
- Analyzes self-statements for their positive and negative effects — BP (WE,231)
- Examines "shoulds" to determine their negative and positive effects — BP (WE,231)
- Revises "shoulds" to reflect the reality of personal needs — BP (WE,231)
- Understands that everyone makes mistakes — BD (WE,231)
- Understands mistakes as a natural consequence of living and limited resources — BD (WE,231)
- Removes self from picture when criticized — BP (WE,231)
- Analyzes criticisms to determine their accuracy and identifies useful lessons learned — BP (WE,231)
- Uses high self-esteem body language — BP (WE,231)

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15. Life Work

The following process was used to identify the standards and benchmarks in this category.

Identification of National Reports and Reference Documents

Standards in the life work category encompass those skills and abilities commonly considered necessary to secure and maintain employment. Two co-reference documents were selected for this category of standards because of their similar purpose and format: What Work Requires of Schools: A SCANS Report for America 2000 (The Secretary's Commission on Achieving Necessary Skills, 1991) and Workplace Basics: The Essential Skills Employers Want (Carnevale, Gainer & Meltzer, 1990). As their titles indicate, both documents are explicitly designed to provide students with guidance in terms of those skills that are valued and expected in the marketplace. In fact, Workplace Basics lists as one of its sixteen categories of skills, Employability — Career Development. In addition to these reports, Benchmarks for Science Literacy (Project 2061, 1992) was identified as relevant to this category.

Identification of Standards and Benchmarks and Integration of Information From Other Documents

Although both reference documents list skills and abilities at a high level of specificity which renders them quite compatible with the structure of standards used in this study, neither identifies the level at which these skills and abilities should be addressed. Consequently, with one exception, the elements listed under the standards in this section are all assigned to level IV. The one exception is the standard entitled "Makes effective use of basic tools." Most of the components for this standard were drawn from the document Science for All Americans, which does list skills and abilities at various benchmark levels.

(WE.281)

1. Makes general preparations for entering work force

Level IV

BD (WE.281)

- Understands basic market trends

BP (WE.281)

- Determines types of preparation and training needed for entry-level jobs

BD (WE.281)

- Understands occupational apprenticeships and other training opportunities

BD (WE.281)

- Understands available educational opportunities (e.g., college, junior college)

BD (WE.281)

- Understands availability of child care

BD (WE.284)

- Understands significant life decisions and their effect on the present

BC (WE.284)

- Analyzes current job and its future possibilities

BC (WE.284)

- Develops an employment profile

BP (WE.281)

- Uses multiple resources to obtain information about prospective jobs (e.g., classified, word of mouth; free services provided by state)

BP (WE.281-283)

- Determines how private employment agencies operate to help people find jobs for a fee

BP (WE.281-283)

- Prepares for common types of employment tests

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D = Duplicated in another standard

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Number
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or, for duplicates:
Standard number & level of duplicate

BP (WE,281-283)

- Applies for social security card, work permit, license

BP (WE,281-283)

- Prepares a resume summarizing experience, education and job training

BP (WE,284-285)

- Establishes an explicit career action plan

BP (WE,281-283)

- Makes accurate appraisal of prior work experience, career goals and personal character, job references and personal aptitudes

BD (WE,281-283)

- Understands nature and function of worker's compensation and unemployment insurance

BP (WE,281-283)

- Evaluates chances of getting a job now and in the future in fields of work that are of interest

BP (WE,284-285)

- Makes accurate appraisal of available work options

BP (WE,281-283)

- Makes accurate appraisal of basic insurance needs

(WE,281)

2. Pursues specific jobs

Level IV

BC (WE,281)

- Determines key contacts within a prospective employer's organization

BC (WE,281)

- Determines specific procedure for applying for a specific job

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1st letter of each code in parentheses
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BD (WE,281)

- Identifies important benefits and procedures of prospective employer (salary, deductions, vacation)

BD (WE,281-283)

- Identifies prospective employer's products and services

BD (WE,281-283)

- Identifies the procedures involved in applying directly for a job at a company's personnel office

BP (WE,281-283)

- Accurately fills out job application

BP (WE,281-283)

- Prepares letters of inquiry on application

BP (WE,281-283)

- Identifies and engages in necessary steps to prepare for job interview

(WE,281)

3. Manages money effectively

Level IV

BP (SE,XVII;WE,281-283)

- Prepares and follows budget

BP (SE,xvii;WE,281)

- Makes forecasts regarding future income and expenses

BP (WE,281-283)

- Uses sound buying principles for purchasing goods and services

BP (WE,281-283)

- Understands credit and uses it effectively

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(WE,281)

4. Makes effective use of basic life skills

Level IV

BP (WE,281)

- Uses telephone correctly

BP (WE,281)

- Uses public transportation effectively

BD (WE,281)

- Understands rules and regulations of Internal Revenue Service

BD (WE,281)

- Understands availability of health care and child care services

BD (WE,281)

- Understands the basic nature of contracts

BD (WE,281)

- Understands the basic process of renting an apartment

BD (WE,281)

- Understands basic banking services (e.g, checking accounts, saving accounts)

BP (WE,281-283)

- Tells time correctly

BD (WE,281-283)

- Understands basic process of buying and maintaining a car

(WE,281)

5. Displays reliability and basic work ethic

Level IV

BP (WE,281)

- Completes tasks on time

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- Chooses ethical courses of action — BP (SI,xviii)
- Establishes an acceptable attendance record — BP (WE,281)
- Uses appropriate language in work situations — BP (WE,281)
- Maintains a sense of congeniality at work — BP (WE,281)
- Maintains an effective work station — BP (WE,281)
- Is attentive to requests and desires of supervisors — BP (WE,281)
- Requests clarification when needed — BP (WE,281)
- Accurately identifies important goals and priorities of employer — BP (WE,375)
- Practices appropriate hygiene and dress at work — BP (WE,281-283)
- Carries out assigned tasks — BP (WE,281-283)
- Does not bring personal problems into work — BP (WE,281-283)
- Prepares, plans and organizes job responsibilities — BP (WE,281-283)
- Recognizes and respects authority — BP (WE,281-283)

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- Accepts guidance and constructive criticism

BP (WE,281-283)

- Demonstrates loyalty to the organization

(WE,375)

6. Operates effectively within organizations

Level IV

BD (WE,375)

- Understands organization's basic goals and values

BD (WE,375)

- Understands the extent to which organizational values are compatible with personal values

BP (WE,375)

- Develops an action plan which identifies how personal skills can be used to increase organizational effectiveness

BP (WE,375)

- Develops and carries out strategies to make personal skills and abilities more visible to an organization

7. Makes effective use of basic tools

Level I

BP (2E,244)

- Uses common fasteners and procedures for fastening (e.g., clips items together, pastes, ties knots)

Level II

BP (2E,245)

- Uses basic hand tools (e.g., hammer, pliers) to shape, fasten and unfasten light materials

Level III

BP (2E,246;SI,xvii)

- Uses hand and power tools to shape, fasten, and unfasten such materials as wood, plastic and soft metal exercising reasonable safety

BD (2E,246)

- Understands basic working principles of simple mechanical devices

BC (2E,246)

- Disassembles simple mechanical devices and describes the relationship among component parts

Level IV

BP (2E,246)

- Uses common hand and power tools to modify, attach and detach all commonly available materials

BP (SE,xvii)

- Uses work space effectively

BP (WE,90)

- Interprets a drawing for assembly or disassembly

Appendix A

Declarative Knowledge Structures
By Levels of Generality

a. Facts. Facts are the most specific type of declarative content. Facts convey information about specific persons, places, things, events and abstractions. That is, they commonly state such information as:

- o The characteristics of a specific person (e.g., The fictitious character Robin Hood first appeared in English literature in the early 1800's).
- o The characteristics of specific places (e.g., Denver is in the state of Colorado).
- o The characteristics of a specific thing (e.g., The Empire State Building is over 100 stories high).
- o The characteristics of a specific event (e.g., Construction began on the leaning tower of Pisa in 1174).
- o The characteristics of an abstraction (e.g., a democracy involves direct vote by the people.)

b. Time Sequences Time sequences include important events that occurred between two points in time. For example, the events that occurred between President Kennedy's assassination on November 22, 1963 and his burial on November 25, 1963 are organized as a time sequence in most people's memories. First one thing happened, then another, then another.

c. Causal Networks. Causal networks involve events that lead somewhere — they produce a product or an effect. A causal network can be as simple as a single cause for a single effect. For example, the fact that the game was lost because a certain player dropped the ball in the end zone, can be organized as a causal network. More commonly though, effects have complex networks of causes; one event affects another that combines with a third event to affect a fourth that then affects another and so on. For example, the events leading up to the civil war can be organized as a causal network. Similarly, processes can be organized as causal networks (e.g., the process for baking a cake).

d. Episodes. Episodes are specific events that have: (1) a setting (e.g., a particular time and place), (2) specific participants, (3) a particular duration, (4) a specific sequence of events and (5) a particular cause and effect. For example, the events of Watergate could be organized as an episode. It occurred in a particular time and place; it had specific participants; it lasted for a specific duration of time; it involved a specific sequence of events; it was caused by specific events and; it had a specific effect on the country.

e. Generalizations. Generalizations are statements for which examples can be provided. For example, the statement, "U.S. presidents often come from families that have great wealth or influence" is a generalization. Examples can be provided for it.

f. Principles. Principles are generalizations considered to be general rules that apply to a given content. In general, there are four types of principles (generalizations) found in school-related declarative information:

1. Cause/effect. One event is caused by another. "Tuberculosis is caused by the bacterium tubercle bacillus."
2. Correlational. The change in one event is related to but does not necessarily cause change in another. "The increase in lung cancer among women is directly proportional to the increase in the number of women who smoke."
3. Probability. The probability of occurrences of one event can be linked to another event. "The chances of giving birth to a boy during any one pregnancy is .52."
4. Axiomatic. A universally accepted generalization within a field. "All people are created equal"; "Complete sentence must have some form of end punctuation unless they are part of a compound or complex sentence."

Some of these types of principles are similar to one or more of the types of structures mentioned previously. For example, cause/effect and correlational principles are similar to causal networks. Axiomatic principles are like generalizations. The difference is that principles are considered as "rules" or "laws" within the content area. The cause/effect principle "Tuberculosis is caused by the bacterium tubercle bacillus" is considered a rule within the field of medicine, however, the generalization "U.S. presidents often came from families that had great wealth or influence" is not considered a rule within any field of study. Of course, this distinction implies that there is some subjectivity as to whether a certain statement is a principle or not. A good rule of thumb is that principles fall into one of the four types mentioned above (cause/effect, correlational, probability and axiomatic) and are held as generally accepted "truths" within a given field.

g. Concepts. Concepts are the most general and most diverse types of organizational structure within a content area. They are usually represented by a single word and commonly include many, if not all, of the other types. For example, the term dictatorship represents a concept. Under that, a teacher or learner could state facts about specific dictators, causal networks about how specific dictators came to power, episodes about the lives of specific dictators and principles about dictators. Thus, this one term, dictatorship,

can be a general umbrella under which all the other types and structures fit. Another characteristic of concepts is that they are at a general enough level that examples can be provided for them. To illustrate, a number of examples of the concept of dictatorship could be easily provided by a learner knowledgeable of this concept.

Appendix B

Procedural Knowledge Structures
By Levels of Generality

a. Algorithms. Algorithms are the most specific type of procedural knowledge. They are comprised of steps that are performed in a fairly strict order. An important feature of algorithms is that they should be performed without much conscious effort to be effective. Examples of processing that tend to be algorithmic in nature include:

* performing addition, subtraction, multiplication and division
* balancing an equation
* diagramming a sentence
* performing different functions on a word processor (e.g., moving paragraphs around)

b. Strategies. Strategies commonly involve the application of basic rules or principles. However, these rules or principles are not necessarily applied in any specific order. In effect, strategies are much "fuzzier" processes than algorithms. The job can be accomplished in a wide variety of ways. Additionally, strategies are not performed as automatically as algorithms. They take some thought to determine the best rule or principle to be applied at any given time. Examples of strategies include:

* reading a chart or a graph
* editing an essay for logic, diction, or mechanics
* determining the meaning of an unknown word
* analyzing a presentation for errors

c. Macroprocesses. Macroprocesses are the most general type of procedural knowledge. As the name implies, they are "big" processes that are commonly comprised of strategies and algorithms. They characteristically take a great deal of conscious thought because you are constantly determining which is the most appropriate action to take next. Examples of macroprocesses include:

* reading for comprehension
* writing different types of expository and narrative texts
* driving a car
* problem solving in various situations
* giving a speech

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